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THE LADIES ASTRONOMY AND CHRONOLOGY, IN FOUR PARTS:

VIZ.

I. A ſhort and eaſy Explanation of the real Nature and Cauſes of the Phænomena of the Celeſtial Lights. The Occaſion of the Eclipſes, and Reaſon of the Tides, the Terreſtrial and Celeſtial Spheres. And the Machine called the *Aſſimilo*, explained. Beginning at *Page* 13.

II. The *Ptolemaic* Syſtem explained; the Reaſons of Days and Nights; their Increaſe, and Decreaſe; the different Seaſons, *viz.* Summer and Winter, Heat and Cold, the Moon's Increaſe and Decreaſe; the Solar and Lunar Eclipſes; and when they happen: All demonſtrated by the *Aſſimilo*. Beginning at *Page* 32.

III. The *Copernican* Syſtem explained, and all the fore-mention'd Particulars demonſtrated, according to that Syſtem, by the *Aſſimilo*; and proved, though the Sun be nearer to us in Winter than in Summer, that will not Counter-change the Seaſons, as many apprehend. Beginning at *Page* 55.

IV. The Elements of Chronology explained, *viz.* Kalendars, Cycles, and Periods, and how to find all the Particulars generally taken Notice of in the Almanacks: And ſolved the moſt uſeful Problems in Navigation, and Aſtronomy; and ſhewn how to find the Variation of the Magnetical Compaſs, and the Latitude by Obſervation: and likewiſe explained the Syſtem of the Planets and Comets, and demonſtrated them by the *Aſſimilo*; which performs every Thing that can be done by the common artificial Globes. As well as the Demonſtration of both the *Ptolemaic* and *Copernican* Syſtems; Beginning at *Page* 83.

This Book was compoſed, and the *Aſſimilo* invented and contrived in the Year 1734.

By *JASPER CHARLTON*,
Officer of the Cuſtoms at *Gainſborough* in the County of *Lincoln*;
And publiſhed by Authority of the King's Royal Order for Letters Patent, for the Term of Fourteen Years.

LONDON: Printed by THOMAS GARDNER in *Bartholomew-Cloſe*, for the AUTHOR; and Sold, either with or without the ASSIMILO, by *John Whiſton*, at *Boyle's-Head*, near *Water-Lane*, *Fleet-Street*; and by *Thomas Scadlethorp*, Bookſeller at *Gainſborough*, *Lincolnſhire*. 1735.

BRITISH MUSEUM

THE
PREFACE.

WHEREAS *the great and noble* Ptolemaus *and* Copernicus, *by the two ſeveral Syſtems which go under their Names; according to their Hypotheſes (or Suppoſitions) have explained the Phanomena (or Appearances) of the Celeſtial Lights.*

And though the Ptolemaic, *and the* Copernican *Syſtems, are prefered before any other; yet theſe two great Aſtronomers differ in their Opinions, concerning the Motions of the Sun and Earth.*

The former ſuppoſes the Sun to move, and the Earth to ſtand ſtill; the latter ſuppoſes the Earth to move, and the Sun to ſtand ſtill.

The Ptolemaic *Syſtem is generally approved of by the Vulgar; but the* Copernican *is now generally received as the moſt probable by the Aſtronomers; and as the great Sir* Iſaac Newton *recommended it above any other, it is by ſome called the* Newtonion *Syſtem.*

And notwithſtanding great Numbers of aſtronomical Books have been publiſhed, for the better Explanation of theſe Syſtems; yet *they ſeem obſcure, and as a Myſtery to the Publick in general; and are not rightly underſtood by many, except the Aſtronomers themſelves. Though ſeveral of thoſe Books contain very good Diagrams (or Figures) for the better Explanation of Aſtronomy, &c. yet ſome ſuch Schemes require a conſiderable Knowledge of deep Geometry and Trigonometry; and indeed, it is no eaſy matter, to project Spherical Bodies upon Planes, ſo as to be underſtood by young Beginners.*

I remember, when I was a School Boy, and learning the Elements of Euclid; *I went on with Pleaſure and Satisfaction, till I came to the eleventh and twelfth Books, which eſtabliſh the Principles relating to Solid Bodies, (not eaſily repreſented upon Paper) I could not get ſo clear an Idea of them as I would, till I contrived ſuch Solid Bodies to be made of Wood, and cut into Sections, and ſo ordered, as they could be taken to Pieces, and put together again as the Caſe required, after which theſe Books appeared as plain as the reſt. If the Motions and Revolutions of the Sun, Earth, Moon, &c. were explained and demonſtrated, ſo as the Knowledge thereof could be eaſily obtained (as generally deſired by almoſt all ſorts of People) that would not only be Encouragement to the learning of ſeveral valuable Sciences, greatly advantagious to Navigation, Commerce, and Trade; but of general Satisfaction to the Publick, and no doubt, great Num-*

bers of both Sexes would take pleaſure to ſpend ſome of their leiſure Hours therein.

For holy David *tells us, in the* 19*th* Pſalm, *That the Heavens declare the Glory of God, and the Firmament ſheweth his Handy Work. And again in the* 97*th* Pſalm, *The Heavens declare his Righteouſneſs; and all the People ſee his Glory. When we know and conſider, how ſo many great Bodies are endowed with Heavenly Light, both beautiful and delightful, their regular Motions, and determined Circulations, ſettled by a divine Law, it muſt neceſſarily raviſh our Minds into an Admiration, Reverence, and Love of God, the Contriver and Maker of theſe, and all Things.*

But I have obſerved, that as the Ptolemaic *and the* Copernican *Syſtems differ in the Motions of the Sun and Earth, it occaſions great Differences and Diſputes in the World, and eſpecially, amongſt thoſe who know but little of either of them: And by this means, not only the noble Science of Aſtronomy, but the whole Body of the Mathematicks, are by many deſpiſed, and little eſteemed.*

For remedy whereof, and in order to reconcile ſuch as are unſatisfied, and for their better Inſtruction, and farther Explanation of both theſe Syſtems, &c. I have compared the ſaid Ptolemaic *and* Copernican *Syſtems together in every reſpect. And for a clear Demonſtration thereof, I have invented and contrived a Mathematical Inſtrument, or Machine, and call it the ASSIMILO, which repreſents the fixed*

Stars, Sun, Moon, and Earth, &c. and they perform their Motions in the ſame Order and regular manner, as their Originals do in the Heavens; and all may be moved by an Aſtronomical Clock; but that would take a Year, to ſhew all the Phænomena (or Appearances,) therefore they are moved by Hand; ſo at any time will anſwer any Queſtion required, and is of more general Uſe, and eaſier underſtood, than any I ever yet heard of.

There have been Inſtruments made, ſome agreeable to the Ptolemaic *Hypotheſis, and others agreeable to the* Copernican *Hypotheſis. Some of which are of little uſe, in reſpect of the Celeſtial Lights, their Motions, &c. and others ſo very coſtly, that none but Perſons of Fortune can purchaſe them.*

But I have contrived my Inſtrument ſo, as to be agreeable to both Hypotheſes, and to explain the Phænomena, or Appearances, thereunto belonging; and ſhew their Difference, and yet to be afforded at a ſmall Price. If any Perſon be deſirous to have the Motions to move by Clock Work, and not by Hand, I will cauſe it to be done accordingly, but then the Price will be greater, and the Inſtrument no better.

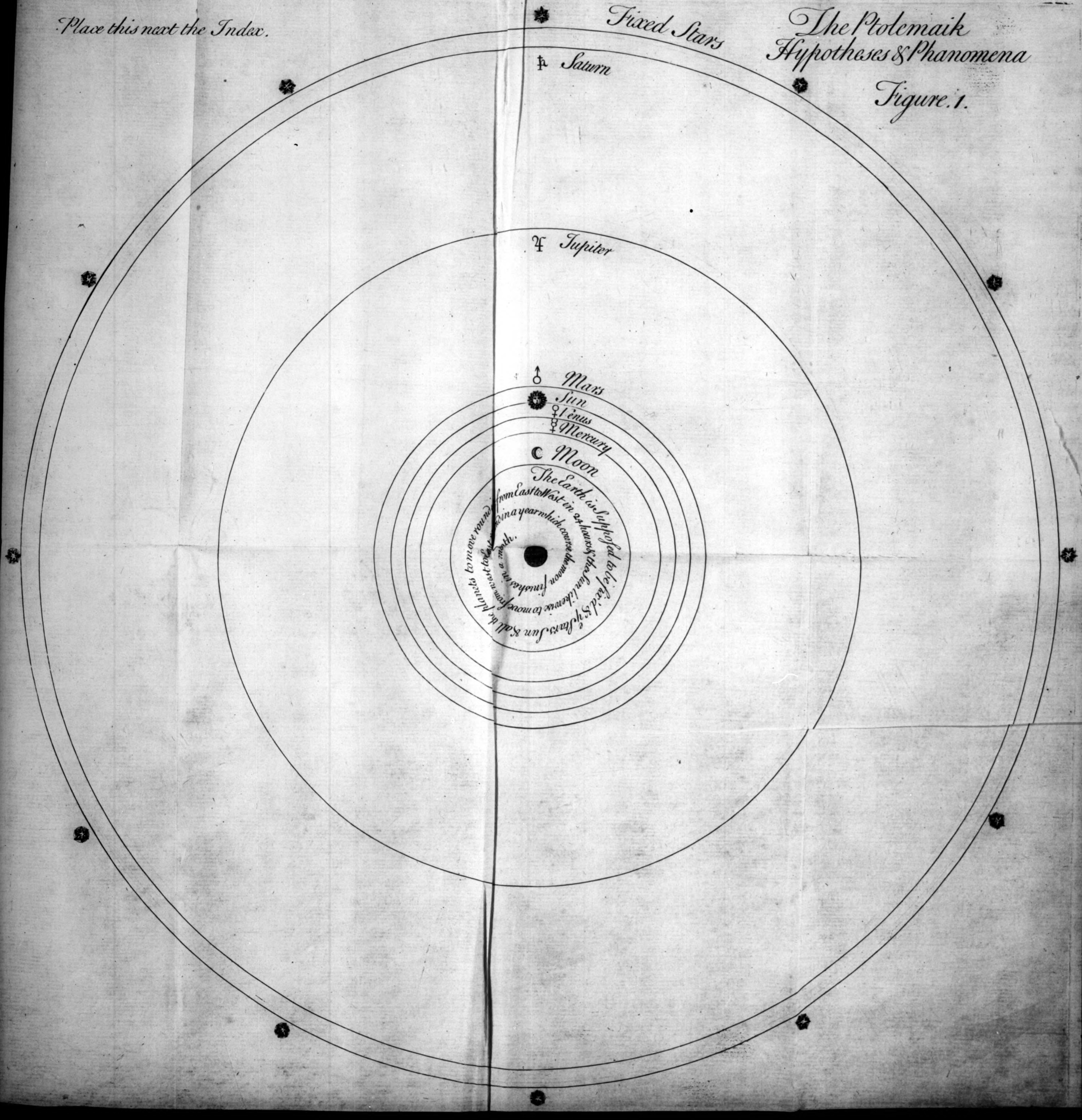
And in order to explain the real Nature and Cauſes of the Celeſtial Phænomena, &c. and ſeveral other things very uſeful to the Publick, as well as the Explanation of the artificial Machine: I have written a Book or Treatiſe, and given it the Title of The Ladies Aſtronomy; *which little Book I have divided into four Parts. As* per *Index.*

THE

Place this next the Index.

The Ptolemaik Hypotheses & Phanomena

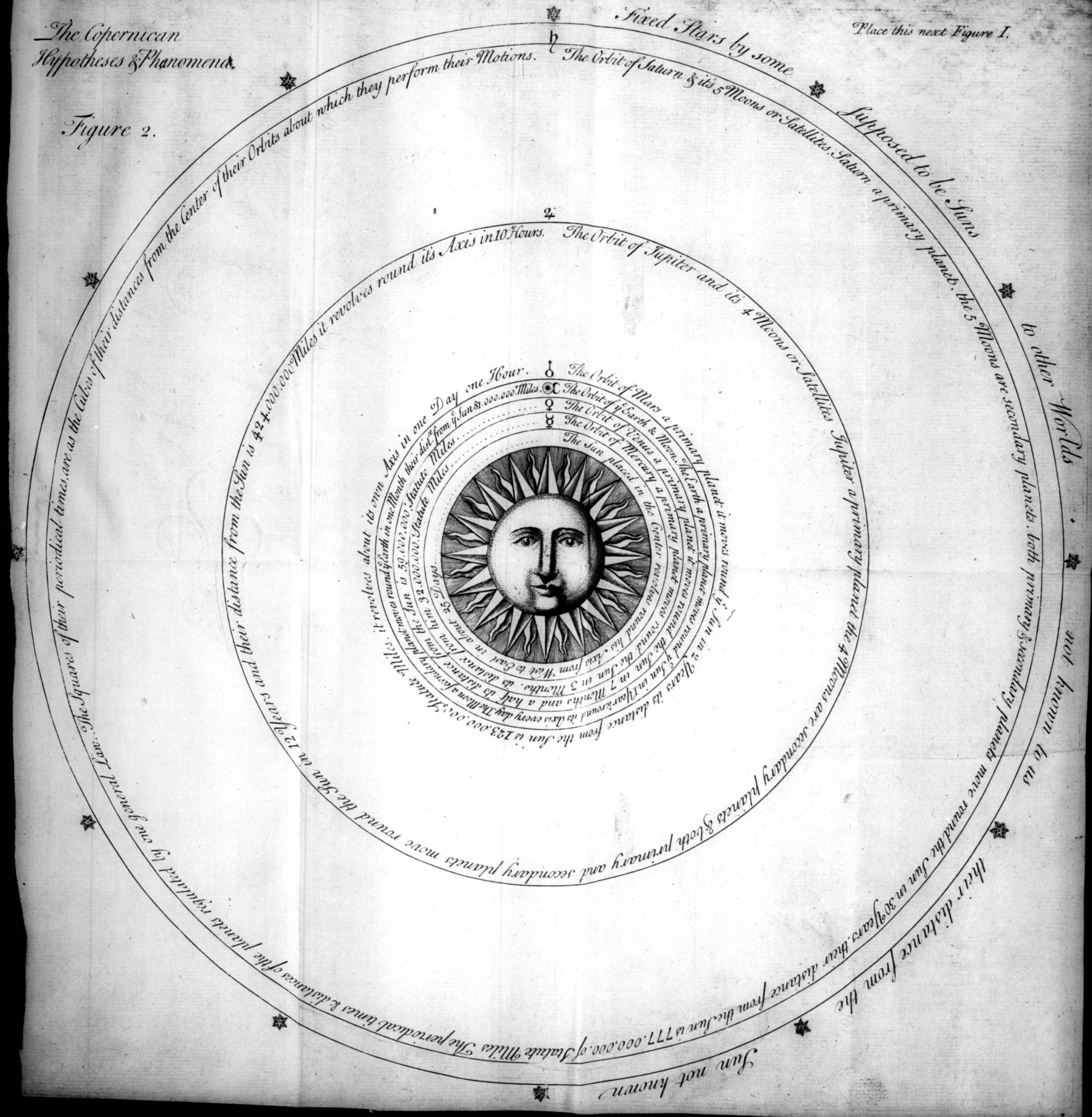
Figure. 1.


Fixed Stars
♄ Saturn
♃ Jupiter
♂ Mars
Sun
♀ Venus
☿ Mercury
☾ Moon
The Earth is ſuppoſed to be fix'd & ye Stars Sun & all the planets to move round from East to West in 24 hours & the Sun likewiſe to move from west to East in a year which course the moon finiſhes in a month.

Place this next Figure I.

The Copernican Hypotheses & Phænomena

Figure 2.


Fixed Stars by some Supposed to be Suns to other Worlds not known to us their distance from the Sun not known
♄ The Orbit of Saturn & its 5 Moons or Satellites. Saturn a primary planet, the 5 Moons are secondary planets, both primary & secondary planets move round the Sun in 30 Years. their distance from the Sun is 777.000.000. of Statute Miles The periodical times & distances of the planets regulated by one general Law: The Squares of their periodical times, are as the Cubes of their distances from the Center of their Orbits about which they perform their Motions.
♃ The Orbit of Jupiter and its 4 Moons or Satellites Jupiter a primary planet the 4 Moons are secondary planets & both primary and secondary planets move round the Sun in 12 Years and their distance from the Sun is 424.000.000 Miles it revolves round its Axis in 10 Hours.
♂ The Orbit of Mars a primary planet it moves round y^e Sun in 2 Years its distance from the Sun is 123.000.00. Statute Miles. it revolves about its own Axis in one Day one Hour.
⊕☾ The Orbit of y^e Earth & Moon. The Earth a primary planet it moves round y^e Sun in 1 Year & round its Axis every day. The Moon a secondary planet moves round y^e Earth in one Month their dist.^{e} from y^e Sun 81.000.000. Miles.
♀ The Orbit of Venus a primary planet it moves round the Sun in 7 Months and a half its distance from the Sun is 59.000.000. Statute Miles
☿ The Orbit of Mercury a primary planet moves round the Sun in 3 Months. its distance from him 32.000.000. Statute Miles
The Sun placed in the Center revolves round his Axis from West to East in about 25 Days.

THE
INDEX.

PARTITION the FIRST.

I HAVE, in a ſhort, eaſy, and familiar way, fully explained the Celeſtial Lights, particularly what is neceſſary in relation to the Sun, Planets, and Stars: The natural Cauſes of Solar and Lunar Eclipſes; when they happen; and the form of the Shadows, which occaſions the Eclipſes; whereby I prove that the Sun is bigger than the Earth, and the Earth bigger than the Moon: And alſo explained the reaſons of the Tides.

I have alſo explained the Terreſtrial and Celeſtial Spheres; and deſcribed all the material Lines and Circles, *&c.* to them belonging; and ſhewn how they are repreſented upon the Inſtrument.

PARTITION the SECOND.

I HAVE alſo explained the *Ptolemaic* Syſtem, and, by ſeveral Inſtances and Examples, ſhewn the Cauſe and Reaſons of Day and Night, their Increaſe and Decreaſe, the different Seaſons, (*viz.*) Summer and Winter, Heat and Cold; the Occaſion of the Moon's Increaſe and Decreaſe; the Solar and Lunar Eclipſes: And clearly demonſtrate all theſe by the Inſtrument.

PARTITION the THIRD.

I HAVE alſo explained the *Copernican* Syſtem, and by the ſame and ſuch like Inſtances and Examples, ſhewn the Cauſes and Reaſons of all the fore-mentioned Particulars, and demonſtrated them by the Inſtrument: And they all come to the very ſame thing; whereby I prove, that all Motions, Revolutions and Periods, *&c.* may be ſufficiently accounted for, by either the *Ptolemaic* or *Copernican* Syſtems, and that they both anſwer the ſame end.

And whereas, the Aſtronomical Books ſet forth, that the Sun is nearer to us (in North Latitude) in Winter, than in Summer; which ſeems a Myſtery to thoſe that are not acquainted with Aſtronomy; and does ſo affect the Minds of many, that they have no regard, to what the Aſtronomers ſay in any reſpect; I have

I have therefore explained the Caſe, and demonſtrated it by the Inſtrument, whereby it appears, that whether it be, or be not ſo, it makes no ſenſible Difference or Alteration in any of the fore-mentioned Particulars; neither can that counter-change the Seaſons, as many People apprehend.

I have alſo ſhewn the Reaſons, why the *Ptolemaic* Syſtem is by ſome rejected, and the *Copernican* Syſtem prefer'd; and demonſtrated that by the Inſtrument.

PARTITION the FOURTH.

IN which are the moſt uſeful Elements of Chronology explained, and the Kalendars, Cycles, and Periods: And by ſeveral Examples, ſhewn how to find all the Particulars, generally taken notice of in the Almanacks, and ſolved the moſt uſeful Problems in Navigation and Aſtronomy, and alſo ſhewn how to find the Variation of the Magnetical Compaſs, and the Latitude by Obſervation, and likewiſe explained the Syſtem of the Planets and Comets; and demonſtrated them by the Inſtrument.

The ASSIMILO, performs every thing that can be done, by the common Artificial Globes, as well as the great uſe, for which it was chiefly invented; as is ſet forth in the firſt three Parts.

The famous and coſtly Inſtrument, called the ORRERY, is very uſeful in explaining the Celeſtial Motions, agreeable to the *Copernican* Syſtem, but the *Copernican* Syſtem is not eaſily underſtood, except the *Ptolemaic* Syſtem be firſt explained; therefore as the *Aſſimilo*, in an eaſy and natural Manner, fully demonſtrates both Syſtems, as well as the uſe of the Globes, *&c.* it far exceeds any Machine ever yet publiſhed.

N.B. Several of my Acquaintances, of both Sexes, by reading my Book, and comparing it with the Inſtrument, have attained a conſiderable Knowledge of the Motions of the Celeſtial Phanomena, and acquired a very tolerable Knowledge of the moſt uſeful Parts of Aſtronomy, with which they are mightily pleaſed. And a Gentleman, who is really Maſter of the noble Sciences of Geometry and Aſtronomy, having peruſed the Book and *Aſſimilo*, adviſed me to endeavour to obtain a Pattent for the ſaid Book and Inſtrument called the *Aſſimilo*.

The King, upon a Repreſentation made to him of the Book and *Aſſimilo*, hath been graciouſly pleaſed to grant His Majeſty's Royal Letters Pattent, for the Term of 14 Years.

CHARACTERS explain'd.

AS the Book is divided into four Parts, the *Index* ſets forth, what is generally treated of in each Partition; but the *Margin* ſhews it more fully and particularly; and the

Reader is to take notice, that the Characters, or Figures, (1) (2) (3) (4) &c. in the principal Part of the Book, denotes, that what is there treated of, is at the ſame Character or Figure, in the lower Part of the Book, farther explain'd; by comparing that Subject, with ſomething naturally or commonly known, in order, that the Reader may eaſily obtain a right and clear Apprehenſion of every thing contained in the Book.

G III R

THE

LADIES *Aſtronomy*.

PARTITION the FIRST.

The natural Cauſes of the Phanomena.

BEFORE I explain the *Ptolemaic* and *Copernican* Syſtems, I will firſt, in a ſhort, eaſy, and familiar way, explain the real Nature and Cauſes of the Celeſtial Lights; what they are, and how placed (or the Hypotheſes and Phanomena, agreeable to both Syſtems, and the Opinion of the moſt learned in Aſtronomy.

Of the Sun.

The Sun is the principal Light, and far the biggeſt and moſt noble Body in the Univerſe, his Diſtance from the Earth is very great, in compariſon of the Moon's Diſtance from the ſame; the Vaſtneſs of the Sun's Magnitude cannot be perceived becauſe of his immenſe Diſtance from us.

Of the Moon and Earth.

The Moon is leſs than the Earth, which is much leſs than the Sun, as is demonſtrated by obſerving the Eclipſes (1): But becauſe the Moon is nearer to us, ſhe appears as big as the Sun, for it is evident, that in viewing the apparent Diameters or Magnitudes of Bodies at a Diſtance, the nearer we approach them, they grow bigger, and for the ſame reaſon it is probable, that the Motions of far diſtant Bodies, which are in themſelves equal, may appear unequal: Though the Sun and Moon be ſpherical Bodies, yet becauſe of their Diſtance from the Earth, we can only ſee a Section of them, therefore they ſhew themſelves to us, as if they were circular Planes. For theſe ſeveral reaſons, the taking of Diſtances, Magnitudes, and Motions of far diſtant Bodies, by Teleſcopes or other Inſtruments, muſt be ſomewhat uncertain; though they diſcover more than what is viſible to the naked Eye, and do very well for what is not at an immenſe Diſtance.

Taking of far diſtant Bodies by Inſtruments uncertain.

OfPlanets their number and how receive their Light.

Both the Earth and Moon are called Planets, as well as five more Bodies; *viz. Mercury*, *Venus*, *Mars*, *Jupiter*, and *Saturn:* See Figures 1 and 2. All theſe ſeven Planets, are opacous Bodies, that is, ſuch as have no Light of their own, but receive all their Light

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The Sun is bigger than the Earth, and the Earth bigger than the Moon.

(1) In time of the Eclipſes, it hath been obſerved, the Moon is ſometimes all involved in the Earth's Shadow, but the Earth is never all involved in the Moon's Shadow, therefore the Earth muſt be bigger than the Moon, and the Sun bigger than either of them, becauſe their Shadows are of a conical Figure, and ends in a Point before it comes to the Planet *Mars*; which never was known to be eclipſed. These Particulars are all demonſtrated by Figure 3, 4, 5, 6, in this Partition.

Light from the Sun; (or from each other, which received it from the Sun) and being ſpherical Bodies, one half of each of them, is always illuminated or enlightned by the Sun, while the other half, or Hemiſphere, is in the dark (2). The Moon appears full, becauſe ſhe is then oppoſite to the Sun, who ſhines full upon her, and we loſe ſight of her, in what we call New Moon, becauſe ſhe is then between us and the Sun, or in Conjunction with him.

Of the Full and Change of the Moon.

The Moon being an opake, rough, ſpherical Body, reflecting the Rays falling upon it, it is evident, that half of it being turn'd towards the Sun is illuminated and bright, while the other half, that is turned from the Sun, continues obſcure and dark. Now only that Hemiſphere of the Moon, which is turn'd towards the Earth, can be ſeen by an Inhabitant of the Earth viewing it; conſequently

Of the Moon's ſeveral Phaſes.

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(2) One half of a ſpherical Body is always enlightned, as will appear by a Ball or an Orange; if you hold an Orange up before your Face, you will ſee one half its Surface at a Time, and by turning it round may ſee all it's Surface at ſeveral Times, if you cut the Orange into two equal Halves, or Hemiſpheres, and hold one of them up with the cut Side towards you, a Perſon oppoſite, could not tell whether it was the whole or half Orange. It is evident one half a Sphere may always be ſeen at a time. and conſequently a ſpherical Body, which receives its Light from the Sun, will be always one half enlightned (if not intercepted) and the other half in the dark. A Superficies, ſuch as a Lady's Fan when ſpread out, may one half of it be ſeen, but no ſolid Body except a Sphere or Globe, can be one half of it ſeen at a time, for if you hold up a Book, you cannot ſee one half of it at one Time: The like Obſervation may be made in viewing other Objects.

One half of a Sphere is always enlightned at a time.

One half of no ſolid Body except a Sphere can be ſeen at one time.

quently the Phaſes of the Moon will be various, according to the various Habitude of the enlightned Hemiſphere, to that which is turned towards the Earth.

The moſt learned in Philoſophy and Aſtronomy, are of opinion, that the Moon is an inhabited World, and as it is a Moon to us, ſo is our Earth a Moon to the Lunar People; and our Earth reflects Light upon our Moon, a little before and after New Moon; and renders faint Light to us.

Of the Forms of Bodies and their Orbits.

There is ſome ſubſtantial and convincing Reaſons, that the Figures of the fore-mentioned Bodies are round or circular, becauſe the out Lines of the Shadows of the Moon, and Earth be always in a circular Form; as may be obſerved in Time of the Eclipſes.

Theſe Bodies are either exactly globular, and move in circular Orbits, or elſe a little oval, and move in Elliptical Orbits. However that Difference can make no ſenſible Error in any Calculation, and is the opinion of Aſtronomers.

Of Stars fixed.

As for the other Celeſtial Lights, called the Fixed Stars; they are ſuppoſed to have no Light from the Sun, but ſhine with their own native Light; therefore not ſubject to an Eclipſe. They are eſteemed to be as ſo many Suns themſelves, to Worlds unknown to us, and ſuppoſed to be vaſtly diſtant, and moſt remote of all the Celeſtial Lights from the Earth; and appear to us as placed in one concave Sphere.

Beſides

Of Stars unfixed.

Beſides the fixed Stars, there appears ſometimes other Stars, or Comets; which ſometimes appear and diſappear, and then re-appear again: They have their Light from the Sun, and are durable Bodies.

Of the Zodiac.

The Tract of the Sphere, in which are twelve remarkable Conſtellations, or Sets of fixed Stars, being fancied to repreſent ſeveral Things, and moſt of them Animals, hence all this Tract is ſtiled the Zodiac; and is ſuppoſed, to be divided into twelve equal Parts, which are by the Aſtronomers, called twelve Signs, theſe twelve Conſtellations or Sets of Stars are denoted by the Names and Characters, as follow; *viz.*

Northern Signs, viz.	*Southern Signs*, viz.
♈ *Aries*, or the *Ram.*	♎ *Libra*, the *Balance.*
♉ *Taurus*, or the *Bull.*	♏ *Scorpius* the *Scorpion.*
♊ *Gemini*, or the *Twins.*	♐ *Sagittarius*, the *Archer.*
♋ *Cancer*, or the *Crab.*	♑ *Capricornus*, the *Goat.*
♌ *Leo*, or the *Lyon.*	♒ *Aquarius*, the *Water-bearer*
♍ *Virgo*, or the *Virgin.*	♓ *Piſces*, the *Fiſhes.*

Of the Zodiac and Ecliptic.

The middle part of the Zodiac, is called the Ecliptic. All the Planets move under the Zodiac, but not always, exactly under the Ecliptic, but their Orbits do croſs one another, according to ſeveral Degrees of Inclination, or according as they croſs the Ecliptic: The two Points wherein the Orbit of any Planet croſſes the Ecliptic, are called the Nodes of that Planet; the Moon's Orbit croſſes the Ecliptic, and makes an

Of the Nodes of the Moon, &c.

Angle of about five Degrees Inclination, ſo the Moon is ſaid to have five Degrees of Latitude, North or South.

The Nodes change their place from Eaſt to Weſt by a retrograde Motion finiſhes the Circulation then returns to the ſame Point of the Ecliptic.

It is found by Obſervation, that the Nodes do conſtantly change their Place from Eaſt to Weſt, contrary to the Order of the Signs; and finiſhes that Circulation, in near nineteen Years; then returns to the ſame Point. (3).

Both the ſolar and lunar Eclipſes.

If the Moon's Orbit was co-incident, or juſt under the Ecliptic we muſt have an Eclipſe of the Sun at every new Moon, and one of the Moon, at every full; but there can be no Eclipſe of either Sun or Moon, unleſs the Moon be in or near the Point of the Ecliptic, where her Orbit croſſes it, which are called the Nodes of the Moon, becauſe otherwiſe the Sun's Light will go by or beſides the Earth or Moon. That which is commonly called the Eclipſe of the Sun, is in reality the Eclipſe of the Earth, wherefore the Earth and Moon being both opacous Bodies, which receive Light from the Sun, an Eclipſe of the Earth (commonly called an Eclipſe of the Sun) is no other than a deficiency of Light on the Earth, by the Moon's coming

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Of the Nodes.

(3) The Nodes by a ſlow, and retrograde Motion, change their Place from Eaſt to Weſt, that is, they move contrary to the Succeſſion of the Signs, and finiſhes that Circulation in between 18 and 19 Years, then returns to the ſame Point of the Ecliptic again. If the Nodes did not change their Place after that manner, the Calculations of Eclipſes would not be tedious. But as it is ſo, theſe Calculations require both Time and Care.

coming between the Earth and the Sun, ſo as to hinder the Rays of the Sun from falling on the Earth; juſt as an Eclipſe of the Moon, is a deficiency of Light in the Moon, by the Earth coming between the Moon and Sun, ſo as to hinder the Rays of the Sun from falling on the Moon. Hence it is evident that all Eclipſes of the Earth (commonly called the Eclipſe in the Sun) happen at or near the change of the Moon, becauſe then only it is, that the Moon comes between the Earth and the Sun; and all the Eclipſes of the Moon happen at or near the full of the Moon, becauſe then only it is that the Earth can come between the Moon and the Sun; in an Eclipſe of the Earth (commonly called an Eclipſe in the Sun) the Moon by intercepting the Rays of the Sun, caſts a Shadow on the Earth, and in an Eclipſe of the Moon, the Earth, by intercepting the Rays of the Sun, caſts a Shadow on the Moon.

The lunar Eclipſes ſometimes total every where. The ſolar Eclipſes cannot be total every where.

It is known by Experience, that the lunar Eclipſes ſometimes are total every where, becauſe the Shadow of the Earth covers all the Moon at one time, conſequently, the Earth is bigger than the Moon, but the ſolar Eclipſes, are never total every where, becauſe the Moon's Shadow cannot cover all the Earth at one time, but only a part thereof, therefore the Moon muſt be leſſer than the Earth; and the Eclipſes appear different or partial, according to the different Places on the Earth, from whence the Spectator may obſerve.

The Sun is bigger than the Earth the Earth bigger than the Moon.

It is alſo demonſtrable, that the Sun is bigger than either the Moon or the Earth; for as much as an opacous Body (4) cannot caſt a conical Shade, but when it is leſſer than the lucid Body (5) whoſe Rays it intercepts. And the Shadows of the Earth and Moon are of a conical Form, as appears by a clear Demonſtration, ſee Figures 3, 4, 5, 6.

Of Shadows.

Duration of Eclipſes.

As the Shadows of the Earth and Moon are conical, the nearer theſe Bodies are to each other [or the more they are vertical to one another] when the Eclipſes happen; the thicker will be the Shadow, and the Eclipſes will be ſo much the greater, and of longer Duration, which is ſo long, as they are in paſſing through one another's Shadow; and before they enter the Shadow, there appears a Dimneſs, which ariſes from a Penumbra, or Duſkiſhneſs, which always attends ſuch Shadows. But the variety that is obſerved, in reſpect to the greatneſs and duration of Eclipſes, does principally ariſe from the Moon's being then more or leſs diſtant from a Node, or the Ecliptic.

Of the Penumbra

Concerning Calculations of Eclipſes.

In *Partition* the *Fourth*, is taught how to find the time of the change and full of the Moon in any Month, in any Year. That being done, it is to be conſidered, whether the Moon be then ſo near to a Node, as to occaſion any Eclipſe at all; if it be found that there will be an Eclipſe, then muſt be known, what Quantity of the Earth, or Moon, will be involved, or immerged, in the other Shadow; and by conſidering their Motions, the Duration of ſuch an Eclipſe may be known according to the Latitude, or Place, for which the Calculation is required.

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(4) Shady, obſure, or dark, not tranſparent, cannot be ſeen thro'.

(5) Clear, bright, ſhining, a Body which emits Light.

The Aſtronomers commonly divide the Diameters of both ſolar and lunar Diſks, into twelve Parts, which they call Digits; and by them they meaſure the Quantity of the Obſcuration, and ſay the Eclipſes are of ſo many Digits, as the obſcured Portion conſiſts of ſuch Parts.

To know whether there will be an Eclipſe in Sun or Moon, or whether any at all.

By Experience and Obſervations it is found, that when the Latitude of the Moon is ſuch, that her Margin juſt touches the Shadow of the Earth, then the Semi-Diameters of the Moon and Shadow, is 66 Menuts or 1 Degree, 6 Minutes; and when the Penumbra, or Shadow, juſt touches the Diſk of the Earth, the Semi-Diameters of the Diſk and Shadow, is 94 Minutes, or 1 Degree, 34 Minutes. Therefore the Proportions according to Trigonometry, are,

	d.	*m.*	
As the Sign of the Angle at the Node	5.	00.	8. 940296
is to the Sign of the Semi-diameters	1.	06.	8. 283243
ſo is the Sign Complement of Ang. at Nod.	85.	00.	9. 998344
			18. 281587
To Diſtance of the Node from the Point of the Ecliptic oppoſite to the Sun, *viz.* 12 *d.* 40 *m.*	12.	40.	9. 341291

therefore if the Moon at full, her Place in the Ecliptic be further from the Node than 12 *d.* 40 *m.* there can be no Eclipſe in the Moon.

	d.	*m.*	
As the Sign of the Angle at the Node	5.	00.	8. 940296
is to the Sign of the Semi-diameters	1.	34.	8. 436800
So is the Sign Comp. of the Ang. at Node	85.	00.	9. 998344
			18. 435144
To Diſtance of the Moon from the Node	18.	10.	9. 494844

Therefore if the Moon at change be further from the Node than 18 *d.* 10 *m.* there can be no Eclipſe in the Sun; but if the Moon be nearer to the Node than 12 *d.* 40 *m.* and 18 *d.* 10 *m.* there muſt be Eclipſes proportional, as ſhe is nearer the Node.

Of the ſeveral Appearances of the Eclipſes.

And all Eclipſes whatever, are either partial, total, central, or both total and central; if an Eclipſe in the Moon be central it is alſo total, but it happens ſometimes, that a central Eclipſe of the Sun is not a total Eclipſe, they are all demonſtrated in the Figure 5 and 6.

To

What is required to be known in Calculations of Eclipſes.

To calculate an Eclipſe, is the niceſt and moſt ſubtle Speculation of Aſtronomy. Firſt it is required, that the true Conjunction of Sun and Moon, and their Oppoſition, the Moon's Latitude and her Diſtance from the Nodes; Rotation and Velocities, Horary Motions (the Way of the Moon from the Sun) the apparent Diameters of the Sun, Moon, Penumbra, Earth, and the Diameters of their Shadows, in the Latitude or Place, where the Calculation is required, be known. All which are generally found out by aſtronomical Tables, made for that purpoſe.

The Cauſes of the Tides.

As for the Tides, ſome of the Aſtronomers ſay, that the Waters of the Sea riſe under the Moon, and the Place oppoſite to it. And others ſay, the Orb of the attracting Power which is in the Moon, is extended as far as the Earth, and draws the Waters under the torrid Zone (6) acting upon Places where it is vertical.

The Author's Obſervations and Opinions.

We find by daily Experience (7), that the Waters ſwell twice, and ſink twice, in the Space of 25 Hours. I have obſerved the Tides

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The Zones.

(6) The torrid Zone is that Space of the Earth contained between the Tropics of *Cancer* and *Capricorn*: The two temperate Zones are contained between the Tropics and polar Circles ? the two trigid or frozen Zones, are contained between the polar Circles and the Poles.

Of the Tides.

(7) *Great Britain* is in the Northern temperate Zone, where the Tides are of as great uſe as any other Place, therefore the Obſervations which I have made (as above explained) ſeem to be the principal Cauſe of the Tides, which will more evidently appear in Partition the 4th.

Tides, and conſidered the Motions an
Places of the Sun, Moon, and other Pl
nets at the ſame Time, and perceive, th
any large Body (but more particularly th
Sun and Moon) hath an Influence upon th
Waters of the Sea, in the Place to whic
they are vertical, or juſt over, the Sun bein
a large Body, though at a great Diſtanc
from the Earth, hath a conſiderable Influ
ence upon the Sea, in that Place to whic
he is vertical: But the Moon being by muc
the nearer to the Earth, hath the greate
Influence (or Virtue) upon the Waters, an
ſhe is the principal Cauſe of our Tides; an
the Time of the Tides are found, by he
coming to the Meridian (as is taught in Par
tition,the 4th).

But when the Sun and Moon, are in Con
junction or Oppoſition, they both have In
fluence, at the ſame Time, upon the ſam
Place, then the Tides are greateſt, bu
they are greater in ſome Places than others
according to the Latitude and Situation o
the Place, and the Declination of the Su
and Moon, which cauſes great Variety.

Of the Magnitudes and Shades.

The Sun is bigger than the Earth, and the
Earth bigger than the Moon, and the Sha
dows of the Earth and Moon are of a coni
cal Figure, and cannot be of any other Form
as demonſtrated by Fig. 3, 4, 5, 6.

The Sun is proved to be bigger than the Earth and

Let us ſuppoſe the Sun and Earth to b
equal in Magnitude, as in Fig. 3. then th
Shadow muſt be cylindrical, that is of an
equal

Place this facing Page 25.

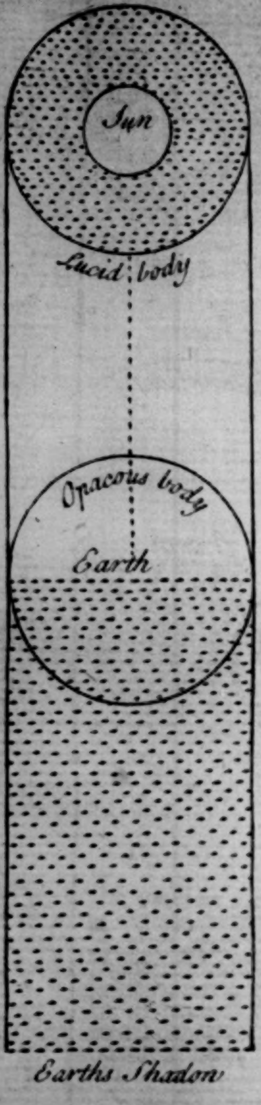

Figure 3

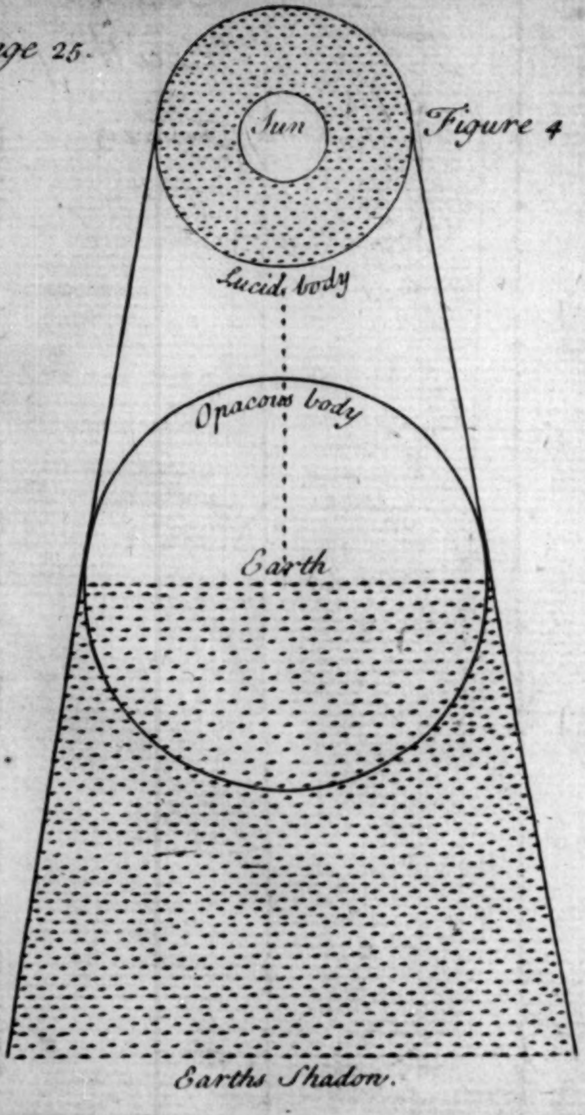

Figure 4

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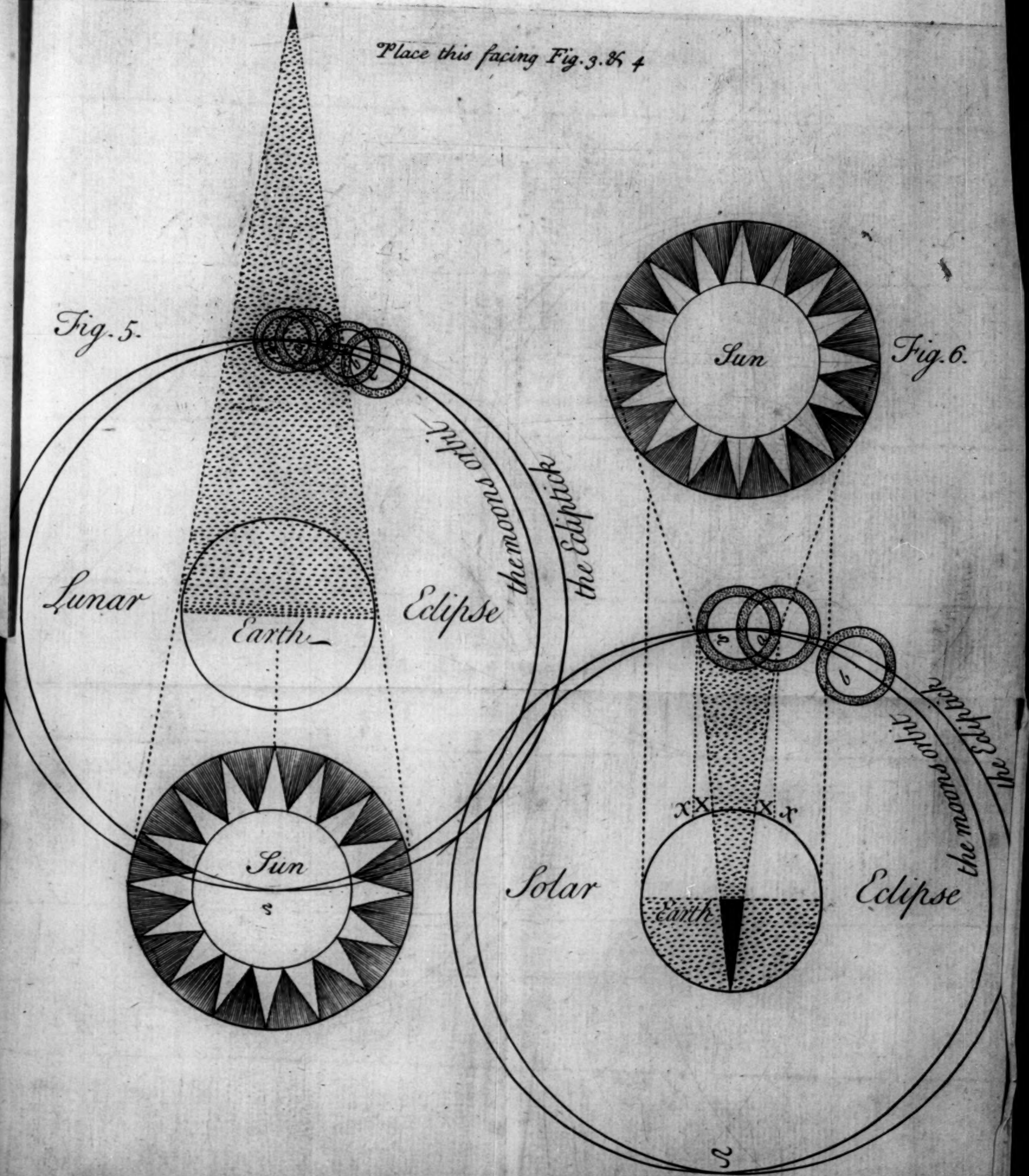
Fig. 5.

Fig. 6.

equal Thickneſs all along; and if the Sun were leſſer than the Earth, as in Fig. 4. then the Shadow would be conical, but inverted the other Way, ſo would grow thicker the farther extended, and both theſe Shadows would be extended in *infinitum* and eclipſe the Planet *Mars*, which never happens, ſo that the Shadow muſt end in a Point before it comes to *Mars*, as in Fig. 5, 6. therefore the Sun muſt be bigger than the Earth, and the Moon leſſer, or elſe ſhe could not all be involved in the Earth's Shadow at one Time.

the Earth bigger than the Moon and their Shadows conical.

Of Eclipſes.

The lunar Eclipſes may ſometimes be total every where, the ſolar Eclipſes cannot be total every where; an Eclipſe may be partial, total, or central; as demonſtrated by Fig. 5 and 6.

The ſeveral appearances of Eclipſes demonſtrated, and when there will be none at all.

The Nodes are denoted *γ Λ*; in Fig 5, the Moon's Center being in the Node *γ* at full, the Eclipſe muſt be central and total; if ſhe was at *a*, it would be total but not central, if at *b* it would be partial, but if at *c*, her Margin ſcarce touches the Shadow, ſo there would be no Eclipſe at all.

In Fig. 6. the Moon's Center being in the Node *γ* at change, the Eclipſe muſt be central and total, to the Inhabitants of the Tract *X X*; but partial to thoſe that live about *x x*; and beyond theſe on each Side, no Eclipſe at all; though that be the greateſt Eclipſe that can happen; therefore the ſolar Eclipſe cannot be total every where, for if the Moon was at *a* the Eclipſe would be leſs, if at *b*, none at all.

Having explained and demonſtrated the natural Cauſes and Phanomena of the celeſtial Lights. I proceed next to explain the terreſtrial and celeſtial Spheres, and deſcribe the Particulars to them belonging, and ſhew how they are repreſented by the *Aſſimilo* (8).

What the Spheres contain.

The terreſtrial Sphere (or Globe) hath, on the Superficies of its Body, the whole form and faſhion of the Earth and Sea, divided into Continents, Iſlands, and Seas. The celeſtial Sphere is a repreſentation of the celeſtial Lights, as they appear to us; (and by ſome called the Starry Heaven) and repreſented by the armillary Sphere in the *Aſſimilo:* The large gilded Ball repreſents the Sun, the leaſt Ball our Moon, and the middle-ſiz'd Ball our Earth. I would have placed the other Planets as in Fig. 1 and 2, in the Machine, but that would have cauſed the Bodies to be made very ſmall, or the *Aſſimilo* to be very large; but the Syſtem of the Planets and Comets are explained by the *Aſſimilo* in *Partition* the 4th.

Of Trietitious Bodies.

The great and all wiſe Creator of theſe Bodies has wonderfully ſettled their Motions by a divine Law, which preſerves them in their proper Orbits; but we, in our artificial Repre-

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Of the Aſſimilo.

(8) *Aſſimilo.* To compare or liken, to reſemble, to make Compariſon. This Machine is a Repreſentation of the Earth and Heavens.

Repreſentations, are obliged to uſe ſome Appurtinances to ſupport and keep them in their Places: And upon theſe are ſeverally mentioned what uſe they are for.

When thoſe are not in uſe they are kept in a little Box fixed to the Frame.

Why Spheres are divided into 360 Degrees.

By Experience (9) it hath be found, that the Circumference of the Earth is 360 Degrees, each Degree about 60 Miles, and therefore the Circumference of the celeſtial Sphere is ſuppoſed to be divided into 360 equal Parts called Degrees, and each of thoſe into 60 Parts called Miles or Minutes. And all Circles are ſuppoſed to be ſo divided (whether real or imaginary) belonging to any Sphere, and thoſe that divide the Sphere into two equal Parts are called great Circles; but ſuch Circles as divide the Sphere into two unequal Parts are called leſſer Circles.

Greater and leſſer Circles.

Of the Circles belonging to the celeſtial Sphere

The Sun's Motion.

The Sun appears to be, twice a Year, upon a Circle called the Equinoctial, which he croſſeth the 10th Day of *March* making an Angle of 23*d.* 30*m.* and apparently moves from Weſt to Eaſt, at the rate of about one

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(9) We attained the Diſcovery of the Earth's Meaſure or Circumference both in *England* and in *France*, a Meaſure in Length hath been taken upon the Earth's Surface, under one and the ſame Meridian, and found to be 360 Degrees, each Degree about 60 Miles, therefore all Circles belonging to any Sphere are ſuppoſed to be divided into 360 equal Parts, called Degrees, which anſwers all Calculations.

The Earth meaſured.

N.B. Degrees are ſometimes denoted by *d*, or *o*, ſet over the Figures; Miles or Minutes are ſometimes denoted by *m*, or 1, ſet over the Figures.

Of Characters.

Degree every Day, for a quarter of a Year which is about 91 Days, then touches a Circle called the Tropic of *Cancer*, being his greateſt Declination (Northward). In about 91 Days more, croſſeth the Equinoctial again, in a Point oppoſite to that he appeared to be in the 10th of *March*, then in about 91 Days touches a Circle called the Tropic of *Capricorn*, being his greateſt Declination (Southward). In about 91 Days more he returns to the Point firſt mentioned, which makes up a Year, ſo will be the 10th of *March* again; and that Circle or Tract, in which he apparently moves, is called the Ecliptic; and to which 8 Degrees on each Side being added, makes the broad Circle called the Zodiac, divided into 12 Parts, each Part containing 30 Degrees, as hath been before explained. At 90 Degrees diſtance from the Equinoctial on each Side are the North and South Poles, and at 23 *d.* 30 *m.* diſtance from each Pole, is a ſmall Circle, theſe are called the polar Circles. Where the Ecliptic croſſes the Equinoctial obliquely, there is another great Circle, croſſes the Equinoctial at right Angles, and is called the Equinoctial Colure; and where the Ecliptic touches the Tropics, another great Circle paſſeth, and croſſes the Equinoctial alſo at right Angles, and called the ſolſtitial Colure: Both theſe Circles may be called Meridians, for all Circles, which croſs the

The Sun's Tract.

the Equator, or Equinoctial, at right Angles, paſſing through its Poles, are Meridians.

Of the Circles belonging to the celeſtial Sphere.

Theſe two Colures interſect each other, in the North and South Poles, which are called the Poles of the World: but where the ſolſtitial Colure croſſeth the polar Circles, are the Poles of the Ecliptic.

The rational Horizon is a great Circle, 90 Degrees diſtant from the *Zenith* and *Nadir* which are its Poles, but both the rational and ſenſible Horizons will always vary, as we ſhift the Place of our View (10).

All the Circles before-mentioned are diſtinguiſhed on the *Aſſimilo*, by having their proper Names written upon them.

Of the Circles belonging to the terreſtrial Sphere.

The Circles, *&c.* belonging to the terreſtrial Shphere, are the ſame with thoſe belonging to the celeſtial Sphere, the Equator in the terreſtrial Sphere is exactly under the Equator, or Equinoctial, in the celeſtial Sphere: And the like is to be underſtood in all the reſt.

Of imaginary Circles.

Circles that croſs the Horizon at right Angles, and meet in the *Zenith* and *Nadir*, are called vertical Circles, or Azimuths. Circles that croſs or interſect each other in the

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Of the ſenſible and rational Horizon.

(10) The ſenſible Horizon is that Space of the Firmament or Heavens, which actually fall under our Senſe of Viſion, and is more or leſs according to the Situation of the Place where we ſtand upon the Surface of the Earth; and will always vary, as we ſhift the Place of our View. As by Experience doth appear, the rational Horizon falls not under our Senſe of Viſion, but is only to be conceived by our Reaſon, to divide the Heavens or Firmament into two equal Halves or Hemiſphere.

the Poles of the Ecliptic, and cut it at right Angles, are called Circles of Longitude. Circles parallel to the Horizon, are called Parallels of Altitude, or Almicanters. Circles parallel to the Equinoctial, are called Parallels of Declination. Circles parallel to the Ecliptic are called Parallels of Latitude. Theſe belong to the celeſtial Sphere.

Of Latitude and Lougitude

But Latitude in the Heavens, and Latitude in the Earth, are different things, the former is counted from the Ecliptic to its Poles, the latter is counted from the Equator to its Poles.

Longitude in the Heavens, and Longitude on the Earth, are vaſtly different, the former is counted from the beginning of *Aries* according to the Succeſſion of the Signs in the Ecliptic; the latter is counted from the Meridian, where Longitude beginneth: (And generally from the Meridian of *London* in *Great Britain.*)

Cardinal Points, vertical Circles, the Meridian.

The Horizon hath four principal or cardinal Points, diſtinguiſhed by Eaſt, Weſt, North and South; among the vertical Circles, thoſe two are of ſpecial Note, which paſs through the cardinal Points of the Horizon. That which paſſes through the Eaſt and Weſt Points is called the prime Vertical; that which paſſes through the North and South Points is ſtiled the Meridian, becauſe every Day, when the Sun comes to that Circle, it is then *Meridies*, or Mid-day, within that Horizon (11). The Meridian is the only vertical Circle which is diſtinctly repreſented on the Sphere. As for all the reſt, they are repreſented in part by the Quadrant of Altitude reſpectively applied to the Body of the Sphere, from the Zenith to the Horizon. It is a long narrow Stripe of Braſs or Wood made thin, that it might be pliant to the Body of the Sphere to which it belongs; and is equal to a fourth Part of the Sphere; and divided into 90 Degrees, &c. as all great Circles are 360 Degrees.

Quadrant of Altitude.

Horizon in the *Aſſimilo.*

The Horizon in the *Aſſimilo*, is repreſented by a wooden Frame, on which is the Points of the Compaſs, a double Kalender of Months and Days, according to the old and new Stile, and the 12 Signs and their Degrees properly placed againſt the Days of any Month; whereby the Sun's Place in the Ecliptic, for any given Time may be readily found.

Upon the Horizon is the Characters of the Sun and all the Planets. And upon the Zodiac are the Characters, Names, and Images of the Signs, being twelve remarkable Conſtellations,

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Of the Meridian.

(11) The Meridian is a great Circle, ſuppoſed to paſs through the Poles of the World, and both Zenith (or Top of the Head) and Nadir (or under the Feet) croſſeth the Equator and Equinoctial at right Angles, and divideth the Earth and Heavens into an Eaſtern and Weſtern Hemiſphere (or two equal Parts) when the Sun cometh to the Meridian of any Place it is then Noon or Mid-day there; they are infinite in Number, for that all Places from Eaſt to Weſt, have their ſeveral Meridians.

ſtellations, or Sets of Stars; and near the Poles are placed the great and little Bears, *&c.* being uſeful Stars: Such Stars as are of no uſe are not placed upon the *Aſſimilo*; for they would take up ſo much Room, ſo as to hinder ſome Demonſtrations.

PARTITION the SECOND.

HAVING in Partition the firſt explained the true Cauſes of the celeſtial Phanomena, as well as the artificial Machine; I will now explain the *Ptolemaic* and *Copernican* Hypotheſes: And becauſe the former is more conceivable than the latter, I ſhall firſt explain the *Ptolemaic* Syſtem; and the Knowledge of that, will be as an Introduction to the other Syſtem.

Ptolemy's Opinion.

Ptolemaus was a famous Mathematician in *Ægypt*, and lived in the latter Part of the ſecond Century after Chriſt. He writ both of Geography and Aſtronomy, and maintains, that the Sun and all the Stars have two Motions, contrary to one another, the one common with the Heavens from Eaſt to Weſt in the Space of 24 Hours, the other proper and peculiar to each, and is from Weſt to Eaſt, which Courſe the Sun finiſheth in the Space of a Year, but the Moon performs it every Month.

Of the diurnal and annual motions

According to this Syſtem the Earth being fixed as the Center, the Sun and Moon moves from Eaſt to Weſt, every 24 Hours; *viz.* 15 Degrees every Hour, and 360 Degrees in 24 Hours. While the Sun is above our Horizon, it is Day, when below, it is Night. They alſo move from Weſt to Eaſt in the Ecliptic according to the Series of the Signs, the Sun moves about one Degree every Day, and the Moon about 13 Degrees every Day, ſo they are 12 Degrees, more and more diſtant from each other every Day; and according to their diurnal Motion, 12 Degrees is 48 Minutes of Time, therefore the Moon is 48 Minutes later and later every Night in coming to the Meridian: From one new Moon to the next new Moon, which is about 30 Days, the firſt 15 Days ſhe increaſes to her full, the other 15 Days, ſhe decreaſes to her change.

Why the Moon comes later every Night to the *Meridian.*

The Ecliptic is divided into 12 equal Parts, called Signs, each Part containing 30 Degrees, the Ecliptic croſſeth the Equinoctial, at the beginning of *Aries* and *Libra*: When the Sun is in either of theſe Points, it is then equal Day and Night all over the World. The Sun enters the firſt Degree of *Aries* the 10 Day of *March*, touches the Tropic of *Cancer* about the 10th Day of *June*, and makes the longeſt Day to thoſe in North Latitude; is at the beginning of *Libra* about the 10 Day of *September*, touches the Tropic of *Capricorn* about the 10th

When equal Day and Night.

Day of *December*, makes the longeſt Day to thoſe in South Latitude; and is at the beginning of *Aries* again about the 10th of *March*; having finiſhed that Period in about a Year, or 365 Days, ſo his Motion is near one Degree every Day: But the Moon moving about 13 Degrees every Day, finiſhes that Period in leſs than 28 Days, and that is called her periodical Month, but though ſhe be then got to the ſame Point where ſhe left the Sun, in the mean while the Sun has moved about 27 Degrees after her, ſo it will be above two Days more before ſhe can overtake him, that makes up about 30 Days, called her ſynodical Month, then ſhe will be in conjunction again with the Sun, and will be what we call new Moon.

Reaſons why it is 30 Days from one change to another.

Of Twylight or the Sun's Rays, &c. and the Hunter's Moon.

We have a conſiderable Light for ſome Time before Sun riſing, and after his ſitting, called Twylight, occaſioned by the Rays of the Sun, refracted in the Atmoſphere (1); and when the Days are longeſt, the Sun being

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Of the Twylight.

(1) It is to the Refraction of the Sun's Rays to the Atmoſphere, that the Twylight is owing; for otherwiſe, as ſoon as the Sun is ſet, it would be preſently quite dark. By Refraction alſo the Sun and Moon appear above the Horizon, when their Bodies are ſomewhat under the Horizon.

Far North or South when the Sun or Moon is in Cancer *ſcarce ſeems to ſet at all.*

In both 2d and 3d *Partitions*, in the principal Part of this Book, I have demonſtrated by the *Aſſimilo*, that if we were in the Latitude of *London*, and the Sun in *Cancer*, his greateſt Declination North, he would then appear to ſtay but a very ſhort time below our Horizon. I have alſo proved that the Moon muſt ſtay a ſhorter time than the Sun below our Horizon, when ſhe is in *Cancer* (or at her greateſt Declination North, and alſo in her greateſt Northern Latitude) I have ing in *Cancer* his Depreſſion below the Horizon is ſo little, there is but one continued Twylight from Sun ſetting to his riſing, it is ſo for ſix Weeks in the Latitude of *London*, but more farther North; and the like Obſervation may be made when the Moon is in *Cancer*.

To demonſtrate the *Ptolemaic* Syſtem by the *Aſſimilo*; it muſt be prepared accordingly. The large Circle denotes the Sun's Or-

To prepare the *Aſſimilo.*

---

have likewiſe ſhewn that if we lived far North they would ſcarce ſeem to us to ſet at all.

The Sun's greateſt Declination is about 23 *d.* 30 *m.* and the Moon's greateſt Declination is above 28 *d.* 30 *m.* therefore the Moon goes full 5 *d.* further North or South, than the Sun, which is the Reaſon that the Moon ſeems to us a little more uncertain than the Sun, and theſe Particulars are all fully explained and demonſtrated by the *Aſſimilo.*

Why the Moon ſeems more uncertain than the Sun.

All the Moons, when in their greateſt Latitude and near full, are alike, and equal both in Light and Motion; but thoſe which happen in the Harveſt and Hunting Seaſon, are moſt taken notice of by the Publick, and by the jolly Fox Hunters, called the Hunter's Moon, but by the good honeſt Country Farmers, the Harveſt Moon; when the Hunters purſue their Game ſo far, as that they cannot return home with Daylight, then a light Moon is of Service to them, and ſometimes the Harveſt People work all Night at their Hay or Corn, then a light Moon is of great Service to them: For which reaſon they take more notice of that Moon than any other. I have proved by a clear Demonſtration that the Moon finiſhes the ſame Courſe every Month, that the Sun or Earth doth in a Year, and that ſhe performs twelve times more work than either of them in a Year; and that the Moon, in her Motions, Revolutions, and Periods, is (to ſpeak in groſs) as conſtant and regular as any other Planet; as appears by the *Aſſimilo*, according to the *Ptolemaic* and *Copernican* Syſtems. But by the ſeveral Motions of the Moon and Earth, and the different Situation of Places, ſometimes both Sun and Moon may appear to us ſeemingly irregular, when in reality they are regular.

Why the Hunter's Moon is ſo called.

Sun and Moon may happen to appear irregular when they are regular bit, in which he moves, it is placed exactly under the Ecliptic, though at ſome Diſtance from it, fixed by four ſhort Pins, the leſſer Circle denotes the Moon's Orbit, in which ſhe moves; it hath the ſame Characters and Diviſions as the Ecliptic; (and both the Ecliptic and Moon's Orbit are properly divided and marked on both Sides) it is placed nearer the Earth than the Sun's Orbit, and not exactly under the Ecliptic, becauſe the Moon hath five Degrees of Latitude (as explained in *Partition* I.) therefore her Orbit muſt have five Degrees Inclination, and are ſo placed by the two long Pins; and the two oppoſite Points where the Moon's Orbit croſſes the Sun's Orbit or the Ecliptic, are the Nodes of the Moon (as hath been explained in *Partition* I.) the long ſtreight Wire, which paſſes through the Poles of the World, is the Earth's Axis, therefore put the Globe of the Earth upon that Wire, and fix it as the Center equally between the two Poles: Put the Sun and Moon in their Places, and fix them in their proper Orbits: The armillary Sphere being placed in the Frame, by putting the large Meridian into the two Notches; that are in the North and South Parts of the Horizon, ſo that the graduated Part thereof be towards the Eaſt, and it reſts in the Notch, that is, in the Bottom of the Frame; The ſaid Meridian may be moved higher or lower till any given Latitude doth juſt touch the upper part of the Horizon, on the North ſide thereof, if North Latitude; but the South ſide, when South Latitude. Place the Hour Circle about the Pole, ſo that the Hours of 12 and 12 lie directly over the graduated ſide of the Meridian; and put he little Index on the Axis, ſo that it may move about as you turn the armillary Sphere; hen doth the upper 12, on the Hour-circle, epreſent 12 at Noon, and the lower 12 at Mid-night; and all the other Figures correſpondent Hours of the Day and Night.

The next thing to be conſidered is, that ll Parts of the Earth, are either in a right, oblique, or parallel Sphere. Such Inhabiants as live upon the Equator, their Horizon croſſeth the Equator at right Angles; nd hence are ſaid to live in a right Sphere; hey have equal Day and Night through the Year. Such as live on either ſide the Equaor, between it and its Poles, their Horizon croſſeth the Equator at oblique Angles, hence heſe are ſaid to live in an oblique Sphere, hey have equal Day and Night only when he Sun is upon the Equator, all the reſt of heir Days and Nights are unequal, and onger or ſhorter, according to the Declinaion of the Sun, and Latitude of the Place. Under the very Poles of the Equator, or of he World, the Horizon and Equator run parallel one to the other, which Poſition is herefore called a parallel Sphere; there it is Day for half the Year together, and Night for the other half.

Where Days are equal and unequal.

The

The Demonſtrations by the Aſſimilo.

Variety 1. Of the Inhabitants upon the Equator,

LET us ſuppoſe ourſelves on the Iſland St. *Thomas*, in the Coaſt of *Barbary*, upon the Equator, the 10th Day of *March*: Put the Sun to the firſt Degree of *Aries* his proper Place, and the Hour Index to 12 at Noon, upon the large Meridian, (for the Index muſt be always ſo ſet to the Sun's Place in the Ecliptic) then the Sun being vertical, or juſt over our Heads, we ſhould have no Shadow. By turning round the armillary Sphere (or Body of the Machine) the Sun ſets upon the Horizon at 6 o' Clock in the Evening, is at the oppoſite Point of the Meridian at 12 in the Night, and riſes upon the Horizon at 6 in the Morning, and is at the ſame Point of the Meridian again at Noon. It may alſo be obſerved, that the Horizon then croſſeth the Equator, or Equinoctial, and conſequently all its Parallels at right Angles, and the North and South Poles are upon the Horizon, and that one half of the Equinoctial, and all its Parallels, (of which the Tropics are two of ſpecial note) are always above the Horizon and the other half below; therefore the Days and Nights muſt be equal. And by moving the Sun a Degree every Day eaſtward, his annual Motion; and alſo turning him round weſtward, his diurnal Motion; in about 91 Days will touch the Tropic of *Cancer*; the Sun would then be 23 *d.* 30 *m.* North

The Sun's diurnal and annual Motions.

orth of us, and our ſhadow ſouth, then ve ſhould not have ſo great heat as when he Sun was vertical; by moving the Sun 1 times more, as before, he would be upon he Equinoctial again, and vertical, ſo we hould have no ſhadow; in 91 Days more he Sun, moved as before, will touch the Tro- ic of *Capricorn*, and will then be 23 *d.* 30 *m.* outh of us and our ſhadow north, and have bout the like heat as when the Sun was in *ancer*; and by moving the Sun as aforeſaid, bout 91 Days more, he will be again in he beginning of *Aries* the 10th of *March*, nd make up the whole Year. And the quator, and its Parallels, being always in the ame Poſition as before, that is, one half of ach of them above, and the other below he Horizon; and the Sun as long above as elow the Horizon each Day and Night, y the Index. Therefore Days and Nights uſt be equal all the Year.

Of the Inhabitants upon the Equator.

The Moon's diurnal monthly and annual Motions and of the Eclipſe in the Sun and Moon.

In *Partition* IV, it is found there is a ew Moon *April* 22 1734. The 22d of *pril* is 43 Days from the 10th of *March*, herefore the Sun is about 43 Degrees from he beginning of *Aries*, *viz.* 13 Degrees in *aurus*: Or look for *April* 22d in the alendar upon the Horizon, and againſt it 13 Degrees of *Taurus*; then ſet the Sun o that Point, and as it is new Moon, the oon is in the ſame Point, therefore ſet the oon to 13 Degrees in *Taurus* upon her own rbit 90 Degrees diſtant from 13 Degrees in *Taurus*; fix the two long Pins, which ſu port the Moon's Orbit, and directs her Incl nation, then will the Moon's Orbit croſs th Sun's Orbit, in the Conjunction which wi be in or near the Node, and in this chang the Moon comes ſo near her Node, as t cauſe a ſmall Eclipſe in the Sun, but inviſibl to any part of *Europe*. The Nodes are explained in *Partition* I. The Body o the Machine being moved round accordin to the diurnal Motion; the Sun and Moo both ſet upon the Horizon together th Day, ſo we have no Light of the Moon but by moving the Sun one Degree and th Moon 13 every Day, according to their proper Motion eaſtward, in two or three Day ſhe is ſo far before him in their eaſtwar Motion, and behind him in their weſtward or diurnal Motion, that there is Moonlight fo a conſiderable time, for there is 48 Minute more every Day; the time of Moonlight i from Sun ſetting to Moon ſetting, we hav no Moonlight while the Sun is above ou Horizon. In 7 Days the Moon has go through a quarter of her Orbit, then whe ſhe is upon the Meridian, the Sun is upo the Horizon, when ſhe is upon the Horizon he is at Midnight, therefore ſhe is calle Midnight Moon. In 14 Days ſhe is go half round her Orbit, and nearly oppoſit to the Sun. Then when the Sun ſets below the Horizon, the Moon riſes above th Horizon, ſo we have always Light; and th next Day being full Moon was ſhe near her Node there would be an Eclipſe of the Moon; but as ſhe was in the Node laſt Change, and in about 14 Days got to the oppoſite Node, in the mean time the Sun hath followed her 14 Degrees, therefore when ſhe is in the Node, is not exactly oppoſite to him and the Earth, but that the Sun's Rays can come beſide the Earth, and ſhine full upon the Moon, ſo there can be no Eclipſe at this full Moon. The next Day they will be 12 Degrees further aſunder, which is equal to 48 Minutes of Time, the Sun will ſet about 48 *m.* before the Moon riſes, and ſo 48 *m.* more every Night; at 7 Days after full, or 21 after change, ſhe will be got through three Fourths of her Orbit; then when he ſets, ſhe is at Midnight; when he is at Midnight ſhe riſeth; in 7 Days more ſhe has got round her Orbit to the Place where the laſt change happened, but in the mean time he has got about 28 Degrees forward after her, but in about 2 Days more ſhe overtakes him, and makes a new Moon in 30 Days, and by 12 ſuch Courſes of the Moon, we ſhall finiſh one *annual* Courſe of both the Moon and the Sun, as was ſhewn in the Sun before; and in uſing the Hour Index for the Sun's riſing and ſetting, as before, the time of Moon riſing and ſetting will appear: It may be obſerved, that when the Moon is increaſing ſhe is to be ſeen only in the Evening, or former Part of the Night, and as the Sun ſets in the Weſt, the Moon's Horns muſt appear to point Eaſt: And when the Moon is decreaſing, ſhe is to be ſeen only in the latter part of the Night or Morning; and as the Sun riſes in the Eaſt, the Moon's Horns muſt appear to point Weſt. What hath been ſhewn either of the Sun or Moon, appears plain in the Machine.

Variety 2. Of the Inhabitants in the Latitude of *London.*

Having in the laſt Example, by the *Aſſimilo* demonſtrated the celeſtial Lights as they appear to the Inhabitants that live upon the Equator, I will next demonſtrate them as they appear to the Inhabitants, in any Latitude. In order to which, we will ſuppoſe ourſelves to be in or near the City of *London*, in *Great Britain.*

The Poles Elevation equal to the Latitude.

In the Example of the right Sphere, we proved that thoſe upon the Equator have the North and South Poles upon their Horizon; therefore if we move from the Equator, towards either Pole, that Pole will accordingly riſe above our Horizon, conſequently the Elevation of the Pole muſt be equal to the Latitude of the Place.

The Machine being prepared, as in the laſt Example; but *London* being in 51 *d.* 30 *m.* North Latitude, move the large Meridian (which moves the Body of the Machine) from North towards South, till 51 *d.* 30 *m.* upon the ſaid Meridian be juſt above the Horizon, then is the Elevation of the Pole equal to the Latitude of the Place, as it always is every where. And then we have the true Poſition of the Heavens, in reſpect of *London.*

The Sun's diurnal and annual Motions.

We will begin with the 10th of *March:* Put the Sun to the beginning of *Aries*, his proper Place, bring that Place to the fixed Meridian, and ſet the Hour Index to 12 at Noon, and it will point to the Sun's Place, (as it muſt always do;) make the Index ſo as it may move about as the Body of the Machine turns round; then we ſee the Sun ſets at 6 o' Clock in the Evening; is at the oppoſite Point of the Meridian at 12, or Midnight; riſes above the Horizon at 6 in the Morning; is at the ſame Point of the Meridian again at Noon: It may alſo be obſerved, though the Horizon, croſſeth the Equinoctial at oblique Angles, one half of it is always above the Horizon and the other below, ſo it muſt be equal Day and Night at that time, all over the World.

But that is only for one Day, for by moving the Sun one Degree every Day eaſtward, his annual Motion, and turning him round weſtward, his diurnal Motion, we plainly ſee the Days muſt increaſe till the Sun be at his greateſt Declination. For inſtance, let us obſerve the 8th Day of *April*, which is 29 Days from the 10th of *March*, therefore the Sun muſt be about the 29th or laſt Degree but one in *Aries*, or by looking in the Kalender upon the Horizon, for the 8th of *April*, againſt it is 29 Degrees of *Aries* the Sun's Place, for if he was moved a Degree every Day he would be there in courſe; Bring that Place to the Meridian, and ſet the Hour Index thereto, as before directed; then we ſee the Sun ſets at 7 o' Clock in the Evening; is at the oppoſite Point of the Meridian (but in the ſame Latitude, and ſame ſide of the Equator moving parallel) at 12; and riſes at 5 in the Morning; and at the ſame Point of the Meridian again at Noon: So that Day is 14 Hours, and the Night but 10. It may be farther obſerved, that though one half of the Equinoctial be then above the Horizon, and the other below, yet its Parallels are all unequally divided by the Horizon, and a greater part of each of them above than below; and as the Sun, in his diurnal Motion, always moves parallel to the Equinoctial, he muſt be longer above the Horizon than below.

By moving the Sun 1 Degree every Day, according to his annual Courſe, in a quarter of a Year, or about 91 Days from the 10th of *March*, *viz.* the 10th Day of *June*, he will be at the beginning of *Cancer*, (his greateſt Declination, then our Days are at the longeſt) the Sun being in the firſt Degree of *Cancer*, his Place; bring it to the Meridian, and fix the Index as before, by turning the Sun weſtward, according to his diurnal Motion, we then ſee he ſets about a quarter of an Hour after 8 in the Evening; is at the oppoſite Point of the Meridian (but in the ſame Latitude and ſame Side of the Equator)

tor) at 12; riſes about three quarters of an Hour after 3; is at the ſame Point again at Noon; ſo our Day is about 16 Hours and a half long, and Night about 7 Hours and an half long.

But this will more evidently appear, by obſerving the Tropic of *Cancer*, the Parallel in which the Sun now moves, it is ſo unequally divided that the greateſt part is above the Horizon, and but a ſmall part below, ſo the Day muſt be ſo much longer than the Night. And the greater the Latitude is, the greater muſt be the Difference between Day and Night, till we come to the Poles, where is but one Day and one Night in the Year, as will appear in the next *Variety*.

The Sun in *Cancer.*

Of the Twylight.

In the Latitude of *London*, when the Sun is in the beginning of *Cancer*, we perceive he is but about ſeven Hours and a half below the Horizon, and all that time is Twilight; for before his refracted Rays in the Atmoſphere leave us in the Evening, they appear in the Morning, ſo that we cannot have Darkneſs during that time.

Days are both the longeſt and hotteſt when the Sun is in the Tropic of *Cancer.*

We may alſo demonſtrate, that in this our Latitude; when the Sun is in the Tropic of *Cancer*, we muſt have the greateſt Heat as well as the greateſt Light from him. For ſince the Sun is the Fountain of Heat as well as Light to the Earth, the nearer he is to us, or our Zenith, or the more he is vertical to us, the greater number of Rays, and greater Heat we muſt receive from him; and we ſee that when he is in the celeſtial Equator, he is vertical, or juſt over our terreſtrial Equator, which is 51 *d.* 30 *m.* diſtant from us, and when he is in the Tropic of *Cancer*, is exactly over that Tropic upon the Earth, which is but 28 Degrees from us, for if from the Latitude of *London*, which is 51 *d.* 30 *m.* we take 23 *d.* 30 *m.* the Sun's greateſt Declination North, remains 28 Degrees, the Sun's neareſt Diſtance from us; therefore when the Sun is at the beginning of *Cancer*, which is the 10th of *June*, our Days muſt be both longeſt and hotteſt, and conſequently is the middle of our Summer Seaſon.

Days are both the ſhorteſt and coldeſt when the Sun is at the Tropic of *Capricorn.*

For by continuing the Sun's Motions, *viz.* one Degree every Day eaſtward, his annual Motion, we ſee he goes farther from our Vertex, and our Days decreaſe, accordingly as they increaſed, and conſequently will grow colder, as before they grew hotter. And in about 91 Days from the 10th of *June*, *viz.* the 10th of *September*, the Sun will be at the beginning of *Libra*, and be upon the Equator again, then the Day and Night will be equal as at the 10th of *March*, and may be proved after the ſame manner; and in 91 Days more, *viz.* the 10th of *December*, the Sun will be at the beginning (or Tropic) of *Capricorn*, then our Days are at the ſhorteſt.

The Sun being in the beginning of *Capricorn* his proper Place, bring that Place to the Meridian, and fix the Hour Index as uſual, then we ſee the Sun, in his diurnal Motion, ſet about three quarters of an Hour after three in the Evening; is at the oppoſite Point of the Meridian (but in the ſame Latitude and ſame Side of the Equator) at 12, or Midnight; riſes about a quarter of an Hour after 8 in the Morning; and is at the ſame Point of the Meridian again at Noon; ſo our Day is but 7 Hours and an half long, and Night about 16 Hours and an half; contrary to what they were when the Sun was in the Tropic of *Cancer*. And this will yet more evidently appear, by obſerving the Tropic of *Capricorn*, the Parallel in which the Sun now moves, there is but a ſmall part of it above the Horizon, the greateſt part is below, ſo the Night muſt be ſo much longer than the Day. And as the Sun is then in the Tropic of *Capricorn*, is exactly over that Tropic upon the Earth, which is 75 Degrees diſtant from us, for if to our Latitude 51 *d.* 30 *m.* we add 23 *d.* 30 *m.* the Sun's greateſt Declination ſouth, the Sun is 75 Degrees, the Sun's greateſt diſtance from us; therefore when the Sun is at the beginning of *Capricorn*, which is the 10th of *December*, our Days muſt be both ſhorteſt and coldeſt, and conſequently is the middle of our Winter Seaſon.

For by continuing the Sun's annual and diurnal Motions, as before, we perceive he comes nearer to our Vertex, and our Days increaſe, accordingly as they decreaſed, and conſequently, will grow warmer as before they grew colder, and in about 91 Days from the 10th of *December*, *viz.* the 10th of *March*, the Sun will be in the beginning of *Aries* again, upon the Equinoctial; having finiſhed his annual or yearly Courſe.

The Sun is nearer to us at Noon than any time of the Day.

By what hath been ſhewn, it is evident that all the Inhabitants on the Earth have the Sun upon their Meridian, every Day at their Noon; and that the Sun is, one time with another, at an equal diſtance from the Earth's Center, and likewiſe from that part of its Surface, to which it is oppoſite, but not always at an equal diſtance from a particular Place on the Earth's Surface. If we lived upon the Equator, and the Sun in the Equinoctial, he would be nearer to us at Noon than any other time of the Day or Night, for at Midnight he would be, all the Earth's Diameter, farther from us than at Noon; when upon the Horizon, he would be about half the Earth's Diameter farther from us than at Noon; and ſo in proportion for any Latitude according to the Sun's Declination: But we ſhould always have the Sun a little nearer to us at Noon than any other time of the Day, or Night, except we lived under the Poles, where is but one Day and one Night in the Year.

We

The Sun appears biggeſt when he is fartheſt from us.

We have, according to this Syſtem, proved the Sun is ſomewhat nearer to us at Noon than at Morning or Evening, and that he is much nearer our Vertex in Summer than in Winter, in the Latitude of *London.*

Yet he appears to us to be rather bigger in the Morning and Evening, than at Noon, and to be rather bigger in Winter than in Summer.

This ſeems to be occaſioned by the Sun's Rays falling more nearly perpendicular upon us, when he is higher and nearer our Zenith, than when he is lower and nearer our Horizon.

Of the Moon's diurnal monthly and annual Motions and Eclipſes.

In *Partition* the 4th it is found,there is a new Moon *May* 21, 1734. from the 10th of *March*, to the 21ſt of *May* is 71 Days, therefore the Sun is about 71 Degrees from the beginning of *Aries*, *viz.* 11 Degrees in *Gemini:* Or look for the 21ſt of *May* in the Kalender upon the Horizon, and againſt it is the 11th Degree of *Gemini*, the Sun's Place; put the Sun to that Place, and as it is New Moon ſhe is in the ſame Point of the Ecliptic, therefore put the Moon to the 11th Degree of *Gemini*, upon her own Orbit, and ſhe will be in conjunction with the Sun, but not ſo near her Node as to cauſe an Eclipſe, the laſt change there was an Eclipſe, and the Moon's Orbit, &c. was fixed accordingly as is there explained, but in this change we ſee that the Sun and Moon is ſo far from the Node that they can paſs one another without cauſing any Eclipſe (the Nodes are explained in Partition the firſt.)

The Sun and Moon both being in the 11th Degree of *Gemini*, *May* 21. By turning the Body of the Machine according to the diurnal Motion, we ſee the Sun and Moon both ſet together that Evening, therefore we have no Moonlight, next Day move the Sun one Degree, and the Moon 13 Degrees eaſtward, their proper Motion, and alſo turn them round weſtward, their diurnal Motion, they will then be 12 Degrees aſunder, which is equal to 48 Minutes of Time, and we ſee the Moon will be ſo much later than the Sun in ſetting upon the Horizon. In 3 or 4 Days, ſhe is ſo far before him in their eaſtward Motion, and ſo far behind him in their weſtward, or diurnal Motion, that we muſt have Moonlight for a conſiderable time.

We muſt conſider, that the time of Moonlight is from Sun ſetting to Moon ſetting, for we never have any Light from the Moon while the Sun is above the Horizon. In 7 Days from the change, the Moon has got through a quarter of her Orbit, (and the Sun only about 7 Degrees further than he was at the change.)

And then before ſhe ſets upon the Horizon we ſee the Sun is at Midnight, therefore called Midnight Moon; if we bring the Sun's Place in the Ecliptic to the Meridian, and fix the Hour Index as uſual, we find the

Sun ſets about a quarter after 8, and that the Moon ſets at 12, or Midnight; and ſo the Hour of her ſetting or riſing may be found at any time. In 14 Days from the Change, the Moon is got half round her Orbit (and the Sun only 14 Degrees from the Change) then we ſee that when the Sun ſets below the Horizon to the weſtward, the Moon riſeth above the Horizon to the eaſtward, ſo that we have always Light, the next Day the Moon will be got right oppoſite to the Sun (called full Moon) if the Moon be then in or near her Node, there will be an Eclipſe in the Moon; but in this full, ſhe is not ſo near the Node but that ſhe can paſs without coming into the Earth's Shadow. Therefore there can be no Eclipſe. And after the Moon is full ſhe will be 48 Minutes later of riſing upon our Horizon every Night.

In 21 Days after change the Moon has got three Fourths through her Orbit, and the Sun 21 Degrees from the Change. Then we ſee that when he is at Midnight, ſhe riſeth upon our Horizon, then the Moon is ſaid to lie in till Midnight .If we bring theSun's Place, in the Ecliptic, to the Meridian, and fix the Index as before directed, we find that the Sun ſets about half anhour after 8, and the Moon riſes upon our Horizon about 12, or Midnight; the like may be done for any other time. In about 28 Days from the Change, the Moon has got round her Orbit, (and the

When the Moon is in *Cancer* and about full we have a long Light from her for the ſame reaſon of the Sun.

Sun forward near 28 Degrees) and in about two Days more the Moon overtakes the Sun, and ſo makes a new Moon in 30 Days. And by ſhewing 12 ſuch monthly Courſes in the Moon, we ſhall ſhew one annual Courſe of both the Sun and Moon as was before demonſtrated, concerning the Sun.

We may perceive, that when the Moon is in *Cancer* and near full, we have a longer Light from her than at any other time, for the ſame Reaſons that hath been given for the Sun's giving the greateſt Light when in *Cancer*.

Of the Nodes and Hunters Moon.

In *Partition* the firſt has been explained that the Moon hath full five Degrees more Latitude than the Sun, and that her Nodes change their Place in the Ecliptic from Eaſt to Weſt by a retrograde Motion, and finiſhes that Circulation in between 18 and 19 Years, then returns to the ſame Point again. Where the Sun and Moon's Orbit croſs each other are the Nodes. Theſe are found in the Machine by fixing the two Iron Pins 90 Degrees diſtant from any Eclipſe, as hath been already ſhown, but at other times the ſaid two Iron Pins are generally fixed in the ſolſtitial Colure.

When the Sun or Moon is in *Cancer* they can but ſtay a very ſhort time below our Horizon but the

If we put the Sun and Moon both to the beginning of *Cancer*, it will then evidently appear, that the Sun can but ſtay a very ſhort time below our Horizon, and that the Moon, if ſhe have North Latitude, muſt ſtay a ſhorter time than the Sun; which cauſes the riſing and ſetting of the Moon to ſeem a little uncertain.

Moon ſtays a leſs time than the Sun.

Of the ſeveral phaſes of the Moon.

We may obſerve thet between the change and full, the Moon is ſeen by us, in the Evening, or former part of the Night; and as the Sun ſets to the weſtward from us, he enlightens the Weſt part of the Moon, which increaſeth more and more; and appears to us firſt horned, then halved, then gibbous, and laſtly full Moon. And between the full and change ſeen by us in the latter part of the Night or Morning, and as the Sun riſes to the eaſtward, he decreaſes the Weſt part of the Moon more and more, ſo that ſhe appears to us, firſt gibbous, then halved, then horned, and laſtly new Moon.

The Cauſes of the ſeveral Phaſes of the Moon, is farther explained in *Partition* the firſt.

Variety 3, and laſt. The Appearances of the celeſtial Lights under the Poles.

Having in the firſt Example by the *Aſſimilo*, demonſtrated the celeſtial Lights, &c. as they appear to the Inhabitants upon the Equator, and in the ſecond Example, how they appear to the Inhabitants in the Latitude of *London*, and the like may be underſtood in any Latitude.

I will in this third and laſt Example demonſtrate how they appear under the very Poles of the Equator, or of the World.

Let us ſuppoſe ourſelves under the North Pole, then we ſhall be in the Latitude of 90 Degrees, and the greateſt Latitude that can be: Turn the Meridian from North towards South, till 90 be juſt above the Horizon; then the Equator and Horizon run parallel one to the other; as long as the Sun ſtays on the ſame ſide of the Equator, ſo long muſt it ſtay above the Horizon of that Pole, and conſequently, ſo long together is Day at the reſpective Pole, and Night at the oppoſite Pole. Put the Sun to the beginning of *Aries*, his Place on the 10th of *March*, he would then be over the Equator, 90 Degrees from us, and would juſt begin to appear upon our Horizon, by moving the Sun one Degree a Day eaſtward, and turning him round weſtward as uſual; in 91 Days, *viz.* the 10th of *June*, he would be at the Tropic of *Cancer*, his neareſt Diſtance, *viz.* 66 *d.* 30 *m.* from us, then would be the middle of that long Day, and we would have the moſt Heat from the Sun at that time. In 91 Days more, *viz.* the 10 of *September*, he would be at the beginning of *Libra*, over the Equator, 90 Degrees from us, then would ſet below our Horizon; in 91 Days, *viz.* the 10th of *December*, will be at the Tropic of *Capricorn*, his greateſt Diſtance, *viz.* 113 *d.* 30 *m.* from us, then would be the middle of that long Night, and we would have the moſt cold. In 91 Days more, *viz.* the 10th of *March*, he will be upon the Equator again; and make up one Year, which to us would appear as a Day and Night.

This will yet more evidently appear, by obſerving that one half of the Ecliptic, *viz.* from the beginning of *Aries*, to the beginning of *Libra*, is always above the Horizon, and the other half below, conſequently one half of the Year muſt be Day, and the other Night. And for the ſame Reaſons, all the Moons during that Night, we would have one half of their periodical Month, *viz.* 14 Days together light, and the other half, *viz.* 14 Days dark.

Of the Moon's Courſe.

In *Partition* the 4th it is found there is a new Moon *September* 17, 1734. Put the Sun and Moon to the 7th Degree of *Libra* their proper Place, we ſee they are not ſo near the Node as to cauſe an Eclipſe; by moving them according to their natural mo-ions, we ſee the Moon is about 14 Days below our Horizon, before ſhe gets to *Aries*, then 14 Days above our Horizon before ſhe gets to *Libra*, but the Sun continues below he Horizon.

PARTITION the THIRD.

HAVING in *Partition* the firſt explained the true Cauſes of the celeſti-l Phanomena, as well as the artificial Machine, and in *Partition* the ſecond explained the *Ptolemaic* Syſtem and demonſtrated it by the Machine, I will in this *Partition* explained plain the *Copernican* Syſtem, and demonſtrate it by the Machine, called the *Aſſimilo.*

Copernicus his Opinion.

Copernicus was a famous Mathematician in *Poliſh Pruſſia*, and lived in the fifteenth Century after Chriſt.

The Sun Moon and Earth's Motions.

He will not believe that the Sun and fixed Stars, turn all round us in 24 Hours, when the bare Motion of the Earth anſwers all Ends as well. The Sun is fixed as the Center, and only moves round his Axis from Weſt to Eaſt in 25 Days. And the Earth to revolve round on its Axis in an eaſy natural manner from Weſt to Eaſt in 24 Hours, makes the Sun appear to do ſo from Eaſt to Weſt. And that the Earth alſo moves round the Sun in the natural Order of the Signs, once every Year. And the Moon's Circle round the Earth, and alſo round her Axis, ſhe performs in about a Month, while at the ſame time ſhe revolves together with the Earth, round the Sun in its annual Courſe.

According to this Syſtem, the Earth in its real Motion is always in the Point of the Ecliptic, oppoſite to that wherein the Sun appears to be. And whatever Point of the Ecliptic the Earth is in at any time, the Sun is ſaid to be then in the oppoſite Point of the Ecliptic.

The Earth's Motions diſputed.

Some will not believe that the Earth turns round, becauſe they cannot perceive it; others ſay, Why are we not all whirled off into the Air like Dirt from a Wheel?

It may be anſwered, that we cannot perceive the Earth's Motion, more than we can the Motion of a Ship, or any thing therein, in a calm Day, and if another Ship lay at Anchor, we ſhould judge that to move backward and not ourſelves forward. And by the Will of the great Creator, the Law of Gravity, whereby all heavenly Bodies have a Tendency towards the Center of our Earth, is much greater than that by which they are forced off by the Earth's Motion round its Axis, or the centrifugal Force, as they call it; and it is this allwiſe Proviſion that keeps all things together on the Surface of the Earth; and alſo keeps every Planet in its proper Circle, and at its due diſtance from the Sun or from its primary one: And this univerſal Law prevails every where.

Sir *Iſaac Newton* his Opinion.

That incomparable Philoſopher, Sir *Iſaac Newton*, has demonſtrated the Laws of Nature, as a Rule that univerſally holds, by which the Sun doth not turn round the Earth, but the Earth turns round the Sun once in a Year. He ſays, that it is certain either the Sun turns round the Earth, or the Earth the Sun in a Year, but he ſays, if the Sun ſhould be made to turn round the Earth, the univerſal Law of Nature would thereby be violated, and the Proportions of the Motions deſtroyed.

To prepare the Machine.

To demonſtrate the *Copernican* Syſtem by the *Aſſimilo*, it muſt be prepared accordingly: Firſt put the Sun upon the long ſtrait Wire which paſſeth through the Poles, and place him equally between the Poles, in the ſame place where the Earth was in the *Ptolemaic* Syſtem; then take notice that as there is a large Meridian and Horizon, wherein the celeſtial Sphere is placed, ſo is there a little braſs Meridian and Horizon, wherein the terreſtrial Sphere muſt be placed, upon the ſhort ſtrait Wire its Axis; and then fixed in the middle of the Moon's Orbit, by two ſhort pins, one of which reacheth from the beginning of *Cancer*, in the Moon's Orbit, to 28 *d.* 30 *m.* from the Eaſt northward upon the Horizon; the other from the beginning of *Capricorn* to 28 *d.* 30 *m.* from the Weſt ſouthward upon the Horizon; for as the Inclination of the Ecliptic from the Equinoctial is 23 *d.* 30 *m.* and the Inclination of the Moon's Orbit from the Ecliptic full 5 Degrees; theſe added together makes 28 *d.* 30 *m.*

Therefore when the Earth's Axis is always held parallel to itſelf, that is, when the Poles of the terreſtrial Sphere points to the Poles of the celeſtial Sphere, then all the Orbits are in a right poſition, and the Sun, and Moon, and Earth, at the ſame diſtance one from another, as they were in the *Ptolemaic* Syſtem.

The Sun being as the center, the large Circle fixed by 4 pins of equal length, called the Sun's Orbit in the *Ptolemaic* Syſtem, is called the Earth's Orbit in this Syſtem: But the Moon's Orbit is the ſame in both Syſtems, for it moves along with the Earth in its Orbit, in this Syſtem, and the Moon's Orbit is ſcrewed faſt to the Earth's Orbit, as the Caſe requires. For to what point ſoever the Earth is moved to, in its Orbit, *viz.* the Ecliptic, in the annual motion; the ſame point in the Moon's Orbit muſt be ſet to the point; and they muſt be faſtened together by the Screw.

The Demonſtrations by the Aſſimilo.

LET us ſuppoſe ourſelves on the Iſland of St. *Thomas*, in the Coaſt of *Barbary*, upon the Equator the 10th of *March*, then the Sun will appear to be in the beginning of *Aries*, and conſequently the Earth muſt be oppoſite, *viz.* in the beginning of *Libra*; ſet the beginning of *Libra* in the Moon's Orbit, to the beginning of *Libra* in the Earth's Orbit (it may be ſcrewed faſt to the large Circle) then we ſee the Sun would be vertical or juſt over our Heads at Noon, being then upon our Meridian.

Variety 1. Of the Inhabitants upon the Equator.

Turn the Earth round according to its diurnal motion from weſt to eaſt, and by that time we are got a quarter round, are at the eaſt part of the Horizon, then the Sun ſeems to ſet in the weſt part of the Horizon; and when we are got half round upon the oppoſite point of the Meridian it is midnight, when three fourths round are upon the weſt part of the Horizon, and then the Sun ſeems to riſe upon the eaſt part of the Horizon,

The Earth's diurnal and annual motions.

and when got quite round, are upon the Meridian again at Noon. The Sun being then over the Equator, will enlighten the Earth from Pole to Pole, and as one half of the Earth is always above the Horizon, and the other below, we muſt be as long above the Horizon as below; conſequently then Days and Nights muſt be equal. And then by moving the Earth one Degree every Day eaſtward, according to its annual motion, and alſo turning it round eaſtward according to its diurnal motion, in 91 Days, *viz.* the 10th of *June*, will be at the Tropic of *Capricorn*; then the Sun will appear to be in the Tropic of *Cancer*, and juſt over that Tropic upon the Earth, ſo 23 *d.* 30 *m.* north from us, therefore we would not have ſo much heat, as when he was over the Equator; by continuing the Earth's two motions, in 91 Days more, *viz.* the 10th of *September* would be in the beginning of *Aries*, then the Sun would appear to be in the beginning of *Libra*, juſt over us, as when we was in the beginning of *Libra*, and we would have the like heat from him.

Then by continuing the Earth's diurnal and annual motions, in 91 Days, *viz.* the 10th of *December*, ſhe would be in the Tropic of *Cancer*, then the Sun would appear to be in the Tropic of *Capricorn*, and juſt over that Tropic upon the Earth, ſo 23*d.* 30 *m.* ſouth from us; therefore we would have the like heat as we had in the Tropic of *Capricorn*, and by continuing the Earth's two natural motions, 91 Days more, *viz.* the 10th of *March*, would be again in the beginning of *Libra*; ſo finiſhed the annual or yearly courſe.

And we may obſerve, that during all that time, we are as long above the Horizon as below it, being in a right Sphere; the Equator and all its Parallels are croſſed by the Horizon at right Angles, conſequently it muſt be there equal Day and Night through the Year.

Of the little Hour Circle and Index.

And in order to make this yet more plainly appear, take notice that there is a little hour Circle and Index belonging to the terreſtrial, as well as the celeſtial Sphere; therefore bring the Iſland of St. *Thomas*, the place that we ſuppoſe ourſelves to be in, to the Meridian, and ſet the hour Index to that place; hence it is evident the Sun riſes and ſets at 6 o' Clock every Day throughout the Year.

It is required to take notice, that there is a moveable, as well as a fixed Horizon belonging to the terreſtrial Sphere, that moveable Horizon denotes that Hemiſphere of the Earth enlightned by the Sun according to his declination; and may be moved higher and lower from the Poles each Day 15 Minutes, according to the Sun's declination, and will ſhew that when the Horizon croſſes the Equator at oblique Angles, all the Parallels to the Equator will be unequally divided; and our Days and Nights will increaſe and decreaſe accordingly.

Of the Moon's monthly and annual motions and the Eclipſes.

In *Partition* the 4th it is found there is a new Moon *April* 22. 1734, Then by the Kalendar (as before taught) the Sun appears to be in the 13th Degree of *Taurus*, and as it is new Moon ſhe muſt be in the ſame point in her own Orbit; and the Earth oppoſite thereto, *viz.* the 13th Degree of *Scorpio.* Put the 13th Degree of *Scorpio*, upon the Moon's Orbit, to the ſame Point in the Earth's Orbit, *viz.* the Ecliptic; we find that this Conjunction is ſo near to a Node, that ſome part of the Earth is involved in the Moon's Shadow, ſo as to cauſe a ſmall Eclipſe on the Earth (commonly called an Eclipſe of the Sun) but inviſible to any part of *Europe*.

Turn the Earth round from weſt to eaſt, according to its diurnal motion, and we ſee the Sun and Moon both ſet together, ſo we can have no moonlight that Night. But by moving the Earth 1 Degree, and the Moon 13 Degrees every Day eaſtward, according to their proper motions, in a few Days the Moon will have outgone the Earth ſo far, that by turning the Earth round according to its diurnal, or daily motion, after the Sun ſets upon our Horizon, it will be a conſiderable time before the Moon ſets upon our Horizon; (and it will be 48 Minutes longer every Night; as hath been before explained.

We perceive no Light from the Moon while the Sun is above our Horizon: But after he is ſet, we have light from the Moon till we be got out of her Hemiſphere: In 7 Days from the change, the Moon hath got through a quarter of her Orbit, after Sun ſets, ſhe gives us Light till we be got out of her Hemiſphere, *viz.* Midnight: In 14 Days from the change, ſhe has got half round her Orbit, then we ſee that as ſoon as the Sun ſets upon our Horizon the Moon riſes, and when the Moon ſets the Sun riſes, for her Hemiſphere then reacheth from one Horizon to the other, ſo we can have no Darkneſs.

As the Moon was in a Node laſt change, ſhe now being got half round her Orbit muſt be in the other Node, but is not yet in oppoſition with the Sun and Earth, for in 14 Days from the change, the Earth is got 14 Degrees forward in its annual motion, but in a Day more the Moon will over-take it, then they will be in oppoſition, and make full Moon.

If ſhe was in or near the Node, there would be an Eclipſe in the Moon, but here we ſee ſhe is got paſt the Node, ſo that the Rays of the Sun can go beſide the Earth, and ſhine full upon the Moon, therefore can be no Eclipſe. In a Day more the Earth is got 1 Degree and the Moon 13 Degrees more eaſtward, ſo will be 12 Degrees aſunder; which is equal to 48 Minutes of Time, therefore after the Sun ſets upon our Horizon, it will it will be 48 Minutes before the Moon riſeth, and ſo much later every Night. In 21 Days from the change, the Moon hath got three fourths through her Orbit, then we ſee, before we come into the Moon's Hemiſphere, that is, before ſhe riſes upon our Horizon, we are at midnight. In 28 Days from the change the Moon is got round her Orbit, but in the mean time the Earth is got near 28 Degrees forward, but in about 2 Days more the Moon overtakes the Earth, and then is in conjunction with the Sun, and makes new Moon in 30 Days. And by ſhewing 12 ſuch monthly courſes in the Moon, we ſhew one annual Courſe of both the Earth and the Moon, as we did before in the Earth.

We may obſerve, that whether or not there be any Eclipſe, yet the Moon's Latitude is always in this poſition a little leſs at new and full, than when half full. The reaſon of the Moon appearing with the ſame Face to us, is becauſe ſhe moves round her Axis in the ſame time that ſhe performs her Circle round the Earth, *viz.* in 1 Month. And ſhe is ſo fixed in the Machine, as to perform both Motions at the ſame time.

Variety 2. Of the Inhabitants in the Latitude of *London.*

In the laſt Example I demonſtrated the celeſtial Lights, as they appear to the Inhabitants upon the Equator. In this Example I will demonſtrate them as they appear to the Inhabitants in any Latitude; in order to which we will ſuppoſe ourſelves in the City of *London* in *Great Britain.* At the

10th of *March*; then the Sun appears in the beginning of *Aries*, the Earth muſt be in the beginning of *Libra*; (and as the Sun always enlightens one half of the Earth at a time, and conſequently that Hemiſphere to which he is oppoſite) the Sun then being over the Equator, will enlighten the Earth from Pole to Pole; and by the diurnal motion of the Earth, we are as long in the Light as in the Dark: Therefore our Day and Night is equal at that time.

But our Days increaſe according to the declination of the Sun, whoſe greateſt declination is 23 *d.* 30 *m.* and performs that in about 91 Days; ſo that this declination is in a Mean, about 15 Minutes in one Day,

Of the Earth's diurnal and annual motions.

By moving the Earth 1 Degree every Day eaſtward, its annual motion; and alſo turning it round eaſtward, its diurnal motion; we ſee the Sun's Light begins to reach beyond the North Pole, and fall ſhort of the South Pole, and more and more what correſponds to 15 Minutes every Day, therefore we muſt be longer and longer in the Light every Day, for 91 Days, *viz.* the 10th of *June*; then the Earth is got to the Tropic of *Capricorn*, and the Sun appears to be in the Tropic of *Cancer*, his greateſt declination northward, and neareſt diſtance to us, conſequently we muſt then have the greateſt heat from him, and then the enlightned Hemiſphere of the Earth oppoſite to him reacheth 23 *d.* 30 *m.* beyond the North Pole, and falls 23 *d.* 30 *m.* ſhort

When the Earth is in the Tropic of *Capricorn*, is the middle of our Summer of the South Pole, equal to the Inclination of the Ecliptic, and the Sun's greateſt declination, therefore our Days muſt be at the longeſt, as well as at the hotteſt, ſo that then is the middle of our Summer Seaſon.

And that this may yet more evidently appear, we may obſerve, when the Earth was in the beginning of *Libra*, the Equator and all its Parallels are equally biſected by the Horizon; after which we may put the moveable Horizon 15 Minutes lower than the North Pole every Day, according to the declination of the Sun, till the Earth be got to the Tropic of *Capricorn*, then we ſee the moveable Horizon reacheth 23 *d.* 30 *m.* beyond the North Pole, and falls 23 *d.* 30 *m.* ſhort of the South Pole, and though it equally divides the Equator itſelf, yet does it unequally divide all its Parallels; and as the greateſt Portion of the North Tropic (in which the Sun appears to be) is above the moveable Horizon, which denotes the enlightned Portion of the Earth, conſequently our Days muſt then be ſo much longer than our Nights. And by uſing the Hour Index we ſee when the Earth was at the firſt of *Libra*, the Sun roſe and ſet at 6 o' Clock; but when the Earth is in the Tropic of *Capricorn*, the Sun riſes about three quarters of an Hour after 3, and ſets about a quarter of an Hour after 8; we may perceive that we are then but a ſhort time below the moveable Horizon, and all that ſhort time is Twylight, as explained in *Partition* II.

The Earth being at the Tropic of *Capricorn* the 10th of *June*, by moving it 1 Degree every Day, its annual motion; and turning it round from Weſt to eaſtward, its diurnal motion; we ſee the Sun's Light begins to come more towards the South Pole, and leſs towards the North Pole, in a Mean, about 15 Minutes every Day, and the moveable Horizon may be ſet accordingly; and in 91 Days, *viz.* the 10th of *September*, the Earth is got to the beginning of *Aries*; then the Sun appears to be in the beginning of *Libra*, and over the Equator; ſo our Day and Night is equal, and the moveable and fixed Horizons are both as one. And they croſs the Equator and all its Parallels at right Angles, juſt as when the Earth was in *Libra*, as before demonſtrated, the Sun's Light is from Pole to Pole.

By continuing the Earth's natural motions, we ſee the Sun's Light begins to reach beyond the South Pole, and falls ſhort of the North Pole; and more and more 15 Minntes every Day: Therefore we muſt be longer and longer in the dark every Night, for 91 Days, *viz.* to the 10th of *December*; then the Earth is got to the Tropic of *Cancer*, and the Sun appears to be in the Tropic of *Capricorn*; his greateſt declination Southward, and greateſt diſtance from us, conſequently then we muſt have the leaſt heat from him.

And then the enlightned Hemiſphere of the Earth reacheth 23 *d.* 30 *m.* beyond the South Pole, and falls 23 *d.* 30 *m.* ſhort of the North Pole; equal to the inclination of the Ecliptic, and the Sun's greateſt declination: Therefore our Days muſt be at the ſhorteſt, as well as at the coldeſt, ſo that then is the middle of our Winter Seaſon.

When the Earth is in the Tropic of *Cancer* it is the middle of our Winter.

And the moveable Horizon having been put 15 Minutes lower than the South Pole every Day, it reaches 23 *d.* 30 *m.* beyond the South Pole, and falls 23 *d.* 30 *m.* ſhort of the North Pole; and though it equally divides the Equator itſelf, yet does unequally divide all its Parallels; and as the greateſt Portion of the South Tropic (in which the Sun appears to be) is below the moveable Horizon, which denotes the enlightned Portion of the Earth, conſequently our Nights muſt then be ſo much longer than our Days; and by uſing the Hour Index, we find the Sun riſes about half an Hour after 8, and ſets about half an Hour after 3.

By continuing the Earth's annual and diurnal motions, we ſee the Sun's Light begins to come more towards the North Pole, and leſs towards the South Pole, about 15 Minutes every Day; and the moveable Horizon may be ſet accordingly, and in 91 Days, *viz.* the 10th of *March*, the Earth is got to the beginning of *Libra* again, then the Sun appears to be in the beginning of *Aries*, and over the Equator; ſo the Earth hath finiſhed its annual or yearly Courſe.

Of the Moon's monthly and annual motions and the Eclipſes.

In *Partition* IV, it is found, there is a new Moon *May* 21. 1734. Look for *May* 21 in the Kalendar upon the Horizon, and againſt it is the 11th Degree of *Gemini*, the Sun's apparent Place, and as it is new Moon, ſhe muſt be upon the ſame Point in her own Orbit, and the Earth oppoſite thereto, *viz.* the 11th Degree of *Sagittarius*; put the 11th Degree of *Sagittarius*, on the Moon's Orbit, to the ſame Place on the Earth's Orbit, *viz.* the Ecliptic: If the Moon be then in or near a Node, there will be an Eclipſe of the Earth, commonly called an Eclipſe of the Sun; but in this Change we find the Moon is not ſo near her Node, as to hinder the Rays of the Sun from falling on any part of the Earth; therefore there can be no Eclipſe. The Sun and Moon being in conjunction, they will ſet both together upon our Horizon that Day, ſo we have no Moonlight, but by moving the Earth 1 Degree, and the Moon 13 Degrees every Day, according to their proper motions eaſtward, we have every Night 48 Minutes more Moonlight, and in 7 Days from the change, the Moon having got over a quarter of her Orbit, we ſee her Light continues till Midnight; in 14 Days ſhe hath got half round her Orbit, then when the Sun ſets upon our Horizon, the Moon riſes; and when the Moon ſets, the Sun riſes; therefore we can have no Darkneſs. Next Day the Moon is got right oppoſite to the Sun, therefore is full Moon, if ſhe be in or near a Node then, there will be an Eclipſe of the Moon, but in this full we find ſhe is not ſo near her Node, but that the Sun's Rays may go by the Earth, and ſhine full upon her, ſo there can be no Eclipſe this full. After this we have 48 Minutes darkneſs more and more every Night, and in 7 Days from full, or 21 Days from the change, the Moon hath got three fourths through her Orbit, then we ſee ſhe cannot riſe upon our Horizon before Midnight. And in 28 Days from the change, the Moon hath got round her Orbit, but in the mean time the Earth hath got near 28 Degrees forward in the Ecliptic; therefore the Moon muſt go above 2 Days more before ſhe overtakes the Earth; and then ſhe is in conjunction with the Sun, and makes a new Moon in 30 Days. And by ſhewing 12 monthly Courſes of the Moon, we ſhew 1 annual Courſe of both the Earth and the Moon, as we have done before, in the Earth.

When the Sun appears in *Cancer*, we can but ſtay a very ſhort time out of his Hemiſphere, but when the Moon

When we demonſtrated the Earth's annual motion, we took notice that when the Earth was in *Capricorn*, and the Sun in *Cancer*, that we could but ſtay a ſhort time below the moveable Horizon, which denotes the Sun's Hemiſphere, or that Portion of the Earth enlightned by the Sun; the ſame Obſervation may be made of the Moon, for the is in *Cancer* we muſt ſtay a ſhorter time out of her Hemiſphere, we have then the longeſt Light from them.

the moveable Horizon alſo denotes the Moon's Hemiſphere, or that Portion of the Earth enlightned by the Moon; but when the Moon is in *Cancer*, and near full, we muſt ſtay a ſhorter time below her Hemiſphere, than we did below the Hemiſphere of the Sun. For the Sun's greateſt declination is but 23 *d.* 30 *m.* and the Moon's 28 *d.* 30 *m.* therefore if we put the moveable Horizon 28 *d.* 30 *m.* below the North Pole, it plainly appears that we can but ſtay a very ſhort time below the Moon's Hemiſphere, when we are in the Latitude of *London*; but if we were farther North at that time, the Moon would ſcarce ſeem to ſet at all; for this reaſon the Moon's ſetting and riſing ſeems uncertain.

Of the Hunter's Moon.

Of the ſeveral phaſes of the Moon.

We may obſerve, that between the change and full, the Moon is ſeen by us in the Evening, or former part of the Night; the Sun ſetting weſtward, cauſes the Horns of the Moon to bend eaſtward; and between full and change, the Moon is ſeen by us, in the latter part of the Night or Morning; the Sun riſing eaſtward, cauſes the Horns of the Moon to bend weſtward.

Variety 3, and laſt. The Appearances of the celeſtial Lights under the Poles.

Having in the Firſt Example in this *Partition*, by the *Aſſimilo*, demonſtrated the celeſtial Lights, to the Inhabitants upon the Equator, and in the ſecond Example, to thoſe in the Latitude of *London*, and the like may be underſtood for any Latitude, I will in this third and laſt Example demonſtrate how they appear in the very Poles of the World.

Of the Earth's diurnal and annual Motions.

We will ſuppoſe ourſelves under the North Pole the 10th of *March*, the Sun then appears to be in the beginning of *Aries*, the Earth is in the firſt of *Libra*. The Sun then being over the Equator, will enlighten the Earth from Pole to Pole. By moving the Earth 1 Degree every Day eaſtward, the annual motion, and alſo turning it round from Weſt to Eaſt, the diurnal motion, we ſee the Sun's Light begins to reach beyond the North Pole, and fall ſhort of the South Pole, more and more ſome 15 Minutes every Day, for 91 Days, *viz.* to the 10th of *June*; then the Earth is got to the Tropic of *Capricorn*, where the Sun ſeemingly, but the Earth really, returns back again; then the Sun's Light begins to come more and more towards the South Pole, and leſs towards the North Pole, ſome 15 Minutes every Day, for 91 Days, *viz.* at the 10th of *September* the Earth is got to the firſt of *Aries*, and the Sun in the firſt of *Libra*, over the Equator, and enlightens the Earth from Pole to Pole; and we plainly ſee that all that time, *viz.* for half a Year, the North Pole was in the Light, and the South Pole in the Dark, then by continuing the Earth's natural motions, we ſee the Sun's Light begins to reach beyond the South Pole, and fall ſhort of the North Pole, ſome 15 Minutes every Day, for 91 Days, *viz.* the 10th of *December*, the

Earth is got to the tropic of *Cancer*, where the ſun ſeemingly, but the Earth really, returns back again; and the Sun's Light begins to come more towards the North Pole, and leſs towards the South Pole, ſome 15 Minutes every Day; for 91 Days, *viz.* the 10th of *March*, the Earth is got to the firſt of *Libra* again, and the Sun in the firſt of *Aries*, and over the Equator, ſo enlightens he Earth from Pole to Pole; is is evident, hat during that half Year, the South Pole was in the Light, and the North Pole in the Dark.

Of the Moon's monthly Courſe.

In *Partition* IV. it is found, there is a new Moon, *September* 17. 1734. By the Kalendar upon the Horizon, the Sun appears to be in the 7th Degree of *Libra*, and he Moon muſt be in the ſame Point of the Ecliptic as it is the change, and the Earth in he oppoſite Point to them; therefore ſet he Moon to the 7th Degree of *Libra* on her own Orbit, and the oppoſite Point, *viz.* he 7th Degree of *Aries*, on the Moon's Orbit, ix'd to the 7th Degree of *Aries* on the Earth's Orbit, *viz.* the Ecliptic. If the Moon be in or near the Node, there will be an Eclipſe of the Earth, (commonly called an Eclipſe of the Sun) but in this change we find the Moon is not ſo near her Node, as that her ſhadow will fall upon any part of the Earth, ſo that there can be no Eclipſe this change: Then move the Earth one Degree, and the Moon 13 Degrees every

Day eaſtward, according to their proper Portions, we ſee the Moon's Light reacheth beyond the South Pole, and comes ſhort of the North Pole, more and more every Day, for 7 Days; then ſhe is at the tropic of *Capricorn*, then her Light begins to come more towards the North Pole, and leſs towards the South Pole every Day for 7 Days; then ſhe is at *Aries* and over the Equator, and enlightens the Earth from Pole to Pole, but it is evident that all theſe 14 Days, the North Pole was in the dark, then we may perceive the Moon's Light reacheth beyond the North Pole, and comes ſhort of the South Pole more and more every Day for 7 Days; then ſhe is at the Tropic of *Cancer*, then her Light begins to come more towards the South Pole, and leſs towards the North Pole, every Day for 7 Days; then ſhe is at *Libra* again, and over the Equator; but it plainly appears that all theſe laſt 14 Days the North Pole had the Light of the Moon: And ſo ſhould we have, in every Moon, her Light for 14 Days together, and be in Darkneſs for 14 Days; that is, during the half Year that we have no Light from the Sun. But theſe 14 Days do not always happen at the beginning nor end of the Moon, but according as ſhe changes in the ſigns, *viz.* in the Ecliptic.

In *Partition* II. I have, by the *Aſſimilo*, according to the *Ptolemaic* Syſtem, demonſtrated the celeſtial Lights, and ſhewn how they appear to any part of the Earth; and by ſeveral Varieties, Inſtances, and Examples, ſhewn the cauſe and reaſons of Days and Nights, their Increaſe and Decreaſe, the different Seaſons, *viz.* Summer and Winter, Heat and Cold, the occaſion of the Moon's Increaſe and Decreaſe, the ſolar and lunar Eclipſes, *&c.* and in this 3d *Partition* have, by the *Aſſimilo*, according to the *Copernican* Syſtem, by the ſame Varieties, Inſtances, and Examples, demonſtrated all the forementioned Particulars; and they all come to the very ſame thing; whereby I prove, that all theſe Motions, Revolutions, and Periods, *&c.* may be ſufficiently accounted for, by either the *Ptolemaic* or *Copernican* Syſtems, and that they both anſwer the ſame end.

What is performed by both Syſtems.

But there are other Phanomena's of the Sun, which are only taken notice of by the more curious in theſe Matters. Such is the different Diſtance of the Sun from the Earth at different parts of the Year, as alſo his appearing of a different Magnitude, and his ſeeming to move at a different rate. And that he is nearer to the Earth in our Winter than in our Summer; and further from the Earth in our Summer than in our Winter. Theſe ſeem great Difficulties to thoſe that are not well acquainted with Aſtronomy, ſo that they have little regard to what the Aſtronomers ſet forth. For ſince the Sun is the Fountain of Heat as well as Light to the Earth, it may be aſked, how it comes to paſs, that the Sun is hotter to us in Summer

The Sun nearer the Earth in Winter that in Summer.

than in Winter; if ſo be he be further from us in Summer than Winter? Therefore I will remove theſe Difficulties, and ſhew that they will not counter-change the Seaſons as many apprehend.

If the Sun be nearer the Earth in Winter than in Summer, that will not counter-change the Seaſons.

The *Aſſimilo*, or Machine, being already prepared according to the *Copernican* Syſtem, the large Circle, which denotes the Earth's Orbit, is fixed at a due diſtance from the Ecliptic by four ſhort Pins, in both Syſtems, but now we muſt take away that Pin, which is in the Tropic of *Capricorn*, and put the Circle cloſe to the Ecliptic, then the Sun will not be in the Center of the Circle, but nearer to *Cancer* than *Capricorn*, (and if the Circle was elliptical, the Sun would not be in the Center, but in a Point in the longer Diameter called the *Focus.*) A Line drawn from *Aries* to *Libra* through the Center of the Sun, equally divides the Ecliptic, but unequally divides the Earth's Orbit; the greater Segment thereof anſwers to the ſix ſouthern Signs, and the leſſer Segment anſwers to the ſix northern Signs; and as the Earth in its annual Motion moves in ſome ſort, each Day alike, conſequently the Earth muſt ſpend more time in paſſing under the ſouthern, than northern Signs; (and is ſuppoſed about 8 Days) therefore the Sun will appear to ſpend leſs time in the ſouthern, than northern Signs, and ſeem to move more ſlowly in the northern, than ſouthern Signs; that is, the Sun ſeemingly moves

Copernican Syſtem.

ſloweſt

floweſt in Summer, when the furtheſt from the Earth; and quickeſt in Winter, when neareſt the Earth.

And as the Sun's Diameter appears leſſer in Summer, and bigger in Winter, ſo the Sun is more diſtant from us in our Summer than in our Winter. Let us ſuppoſe ourſelves in the Latitude of *London*, and begin with the 10th of *March*, then the Sun appears to be in the firſt of *Aries*, and the Earth is in the firſt of *Libra*; by moving the Earth 1 Degree every Day eaſtward, according to the ſeries of the Signs, its annual motion, and alſo turning it round every Day from Weſt to Eaſt, according to its diurnal motion; till it be at the Tropic of *Capricorn*; then the Sun appears in the Tropic of *Cancer*, and is the middle of our Summer; and we ſee that then the Earth is at its greateſt diſtance from the Sun, by continuing the Earth's proper motions; till it is got to the firſt of *Aries*; then the Sun appears to be in the firſt of *Libra*, and we ſee the Earth is at the ſame diſtance from the Sun as when it was in the firſt of *Libra*; by continuing the Earth's natural motions, till it is at the Tropic of *Cancer*; then the Sun appears to be in the Tropic of *Capricorn*, and is the middle of our Winter; and we ſee that then the Earth is at its leaſt diſtance from the Sun,

Sun; by continuing the Earth's proper motions, it is got to the firſt of *Libra* again, ſo finiſhed its annual Courſe as uſual. And we plainly ſee that the cauſe and reaſons of Days and Nights, their Increaſe and Decreaſe, and the different Seaſons of the Year, are all the ſame as when the Sun was placed in the Center; only it is to be obſerved, that the Sun is nearer to us in Winter than in Summer. But it is obvious, that doth not counter-change the Seaſons; for we have not the greateſt heat from the Sun, when we are neareſt to him; our different heat does not ſo much depend upon that as upon the Quantity or Number of the Sun's Rays or particles of Light, and their falling more directly or more obliquely upon us, a little approach of the Earth to, or its receſs from the Sun, will make no ſenſible Alteration as to heat or cold.

Ptolemaic Syſtem.

Having explained and demonſtrated theſe Hypotheſes and Phanomena, according to the *Copernican* Syſtem; I now proceed to ſhew them according to the *Ptolemaic* Syſtem. The Machine being prepared according to the *Ptolemaic* Syſtem; take away the Pin, which is in the Tropic of *Cancer*, and put the Circle cloſe to the Ecliptic, then the Earth will not be in the Center, but nearer to *Capricorn* than *Cancer*; then the Circle which now denotes the Sun's Orbit, will be unequally divided as before, the greater Segment whereof (now) anſwers to the ſix northern Signs, and the leſſer ſegment anſwers to the ſix ſouthern Signs; and as the Sun in his annual motion moves nearly every Day alike, conſequently the Sun muſt ſpend more time in the northern than ſouthern Signs, (which time is ſuppoſed to be about 8 Days) and ſo ſeems to move more ſlowly in the northern than ſouthern Signs; that is, the Sun moves ſloweſt in Summer, when furtheſt from the Earth; and quickeſt in Winter, when neareſt the Earth; and the Sun's Diameter appears leſs in Summer and bigger in Winter. So the Sun is more diſtant from us in our Summer than in our Winter.

Let us begin with the 10th of *March*, then the Sun is in the firſt of *Aries*; by moving the Sun 1 Degree every Day eaſtward, according to the Series of the Signs, his annual motion, and alſo turning him round every Day from Eaſt to Weſt, according to his diurnal motion, till he be at the Tropic of *Cancer*, is the middle of our Summer; we ſee that then the Sun is almoſt at his greateſt Diſtance from the Earth; by continuing the Sun's motions, till got to the firſt of *Libra*; we ſee he is at the ſame Diſtance from the Earth, as when he was in the firſt of *Aries*; by continuing the Sun's motions, he is at the Tropic of *Capricorn*, is the middle of our Winter, and we ſe- then the Sun is almoſt at his leaſt Diſtance from the Earth; and by continuing the Sun's motions till he is at the firſt of *Aries* again, ſo has finiſhed his annual Courſe as uſual; and we ſee that the Cauſe and Reaſons of Days and Nights, and the different Seaſons of the Year, *&c.* are all the ſame as when the Earth was placed in the Center, only the Sun is nearer to us in Winter than in Summer, which cannot counter-change the Seaſons, for the Reaſons given before. For the Sun feels more or leſs hot to us, not only as it is nearer or further from us, but alſo as its Rays come more in number, and more or leſs directly to us. Whence though the Sun be further from us in Summer than in Winter, yet becauſe its Rays are much more in number, and more nearer prependicular to us in our Summer than in our Winter, the Sun is hotter to us in our Summer than in Winter.

I have now fully explained and demonſtrated the fore-mentioned Hypotheſes and Phanomena, according to the *Ptolemaic* and *Copernican* Syſtems; and they both anſwer the ſame end; which farther proves, that theſe Phanomena, may be ſufficiently accounted for, by either the *Ptolemaic* or *Copernican* Syſtems.

As

Some of the Aſtronomers opinion that the Sun is nearer the Earth in our Winter than Summer.

As Aſtronomers ſet forth, that the Sun is nearer to the Earth in our Winter than Summer, that ſeems a greater Myſtery to the Publick, than any other part of Aſtronomy, and doth ſo effect the Minds of many, that they have no regard to what the Aſtronomers ſay; for which reaſon I have fully explained the Caſe, and demonſtrated it by the *Aſſimilo*, by which it appears, that though it be ſo, it will not counter-change the Seaſons as ſome apprehend. But it is rationally ſolved by the annual motion of the Earth in an elliptical Orbit round the Sun, placed in one of the Focuſes of the Eclipſes, according to the *Copernican* Syſtem; or by ſuppoſing the Earth ſo placed according to the *Ptolemaic* Syſtem; as I have ſhewn.

As to whether Orbits be elliptical or circular, makes no ſenſible Difference as in this Doctrine of the Sphere, as explained in *Partition* I. but if Bodies are unequally placed in their Orbits, it makes ſome Alteration; if the Sun be not in the Center of the Earth's Orbit, but nearer to one end, then it is plain the Sun is nearer to the Earth in our Winter than in our Summer; (as we are in the North Latitude.) And thoſe in South Latitude have the Sun neareſt to the Earth in their Summer.

The Reaſons given why the Sun is nearer to the Earth in our Winter than in Summer are theſe:

Reaſons why the Sun is to be ſuppoſed nearer to the Earth in Winter than in Summer.

1. By Obſervation the Sun tarries about 8 Days longer in the North, than in the South of the Ecliptic.

2. He then appears to move ſlower than in our Winter, ſo farther from us.

3. His apparent Diameter is bigger in Winter than in Summer, ſo nearer to us.

Which Obſervations certainly demonſtrate the Sun to be neareſt to us 8 Days after the ſhorteſt, and fartheſt off 8 Days after the longeſt Day, I mean in this Age only.

The reaſons why the *Copernican* Syſtem is prefered before the *Ptolemaic* Syſtem.

Having explained and demonſtrated all the Hypotheſes and Phanomena, according to both the *Ptolemaic* and *Copernican* Syſtems, I now come to ſhew the Reaſons why the former is by ſome rejected, and the latter preferr'd. In the *Ptolemaic* Syſtem the Earth is the Center, and the Sun, and Moon, and fixed Stars, all turn round it from Eaſt to Weſt in the ſpace of 24 Hours, by the Revolution of the *Primum-mobile*; and the Sun alſo goes round from Weſt to Eaſt in a Year; as appears by the ſeveral Examples in *Partition* II. In the *Copernican* Syſtem, the Sun is the Center, and the Earth turns round on its own Axis from Weſt to Eaſt in 24 Hours, and alſo moves round the Sun in a Year, as appears by the ſeveral Examples in *Partition* III.

That Hypotheſis is to be eſteemed moſt agreeable, which explains the motions whence the celeſtial Phanomena ariſe, after the moſt ſimple (or uncompounded) and uniform manner; and beſt agrees to mathematic Demonſtrations, and aſtronomical Obſervations; that is, which adjuſt the ſaid motions to the feweſt Laws and Principles: And herein the *Copernican* excels the *Ptolemaic* Syſtem. For which reaſon, the *Copernican* Syſtem is now generally received by the more learned in Aſtronomy; and though I have taken great pains in explaining and demonſtrating the *Ptolemaic*, as well as the *Copernican* Syſtem, (the former being as an Introduction to the latter) in order to reconcile ſuch as are unſatisfied, and for their better Inſtructions, and farther Explanation of both Syſtems; nevertheleſs, I prefer the *Copernican* before the *Ptolemaic* Syſtem.

PARTITION the FOURTH.

HAVING in *Partition* I. explained the natural Cauſe of the celeſtial Lights, &c. as well as the artificial Machine, and in *Partition* II. explained the *Ptolemaic* Syſtem, and in *Partition* III. explained the *Copernican* Syſtem, both by the *Aſſimilo*. In this IVth and laſt *Partition*, I will explain the moſt uſeful Elements of Chronology, and the Kalendars, Cycles, and Periods, and by ſeveral Examples ſhew how to find all the Particulars, generally taken notice of in the Almanacks; and ſolve the moſt uſeful Problems in Navigation and Aſtronomy; and alſo ſhew how to find the Variation of the magnetical Compaſs, and the Latitude by Obſervation, and explain the Syſtem of the Planets and Comets, and demonſtrate them by the *Aſſimilo*.

Chronological Inſtitutions.

By Chronology is underſtood the Art or Skill of adjuſting things paſt to their proper times. Hence chronological Inſtitutions conſiſt of the Explication of the ſeveral parts into which Time in general is divided; and of the ſeveral Characters by which particular Times are diſtinguiſhed one from another.

Of Days, Hours, and Minutes.

The ſeveral parts of Time are, Minutes, Hours, Days, Weeks, Months, and Years. Some call the time from Sun-riſing to Sun-ſetting a Day, and from Sun-ſetting to Sun-riſing a Night. Others call the whole Revolution of the Sun round the Earth a Day, and this ſort of Day is moſt applied to uſe; and divided into 24 equal parts, called Hours; and thoſe Hours, divided into 60 equal parts, are called Minutes. (1)

And

When Day may begin and end.

(1) That Day is ſometimes called the *Nuchthemeron*: it may be reckoned either from Sun-ſetting to Sun-ſetting, or from Sun-riſing to Sun-riſing; or from Mid-day to Mid-day, or from Mid-night to Mid-night.

Of Days, Weeks, Months, and a Year.

And 7 of thoſe Days is a Week (2), and 4 Weeks a Month; but that Month conſiſts only of 28 Days; in leſs than which time, the Moon moves round the Ecliptic; and which time of the Month's Revolution, is called the Moon's periodical Month; the time of one new Moon to another, is called the Moon's ſynodical Month; and conſiſts of about 29 Days and a half, and 12 ſuch Months or Moons, is called a lunar Year, and conſiſts of above 354 Days. For 29 and a half multiplied by 12 is 354. (3)

Of Leap-year.

The time wherein the Sun appears to move round the Ecliptic, is called a ſolar Year, and conſiſts of 365 Days and almoſt 6 Hours; but the Hours are only reckoned every fourth Year, ſo makes up a Day, which is added to *February*, then that Year conſiſts of 366 Days, and is called a Leap-year. The ſolar Year is moſt applied to uſe: Therefore the ſolar Months ſtand in our Kalendar as in the following Table.

Days have their names from the Planets.

(2) That is the moſt antient Collection, as from the ſacred Hiſtory, God created the World in 6 Days, and reſted on the 7th from all his Works. The 7 Days of the Week are commonly diſtinguiſhed by the name of the Planets, viz, *Saturn*, *Jupiter*, *Mars*, the *Sun*, *Venus*, *Mercury*, and the *Moon*.

(3) The Moon's periodical and ſynodical Months, and the reaſons of their difference, is explained in the firſt *Partition*.

Calendar Months.

Months.	Days.	Months.	Days.
March,	31	*September*,	30
April,	30	*October*,	31
May,	31	*November*.	30
June,	30	*December*,	31
July,	31	*January*,	31
Auguſt,	31	*February*,	28
	184		181
			184
		A Common Year	365
		But every fourth Year *February* hath 29 Days,	001
		A Leap Year,	366

When the Year beginneth.

The firſt Day of *January* is now-a-days commonly looked on as the beginning of the Year, whether *Julian* or *Gregorian*; yet there are ſome, who reckon the beginning of the Year from the 25th Day of *March*, commonly called *Lady-Day*.

	Days.
Having ſhewn the reaſon why the ſolar Year contains	365
And alſo why the lunar Year contains but	354
Their Difference, which is	11

is

Of the Epact.

is (4) the Difference between the old and new Styles, and thoſe 11 Days is alſo called the Epact. Its Uſe hereafter will appear.

Of the Cycles of the Moon, Sun, and Indiction.

The Cycle of the Moon, Golden Number, or Prime, is a circular Revolution of 19 Years, in which ſpace of time, the Sun and Moon finiſh nearly all their *Variety* of Aſpects. The Cycle, or Circle, of the Sun, maketh its Revolution in 28 Years, in which time all the *Variety* of Dominical Letters, and Leap-years expire. *Roman* Indiction conſiſts of 15 Years, for once in 15 Years the Nations were to receive Donations from, or pay Tributes to the *Romans*, a thing out of uſe with us.

Of the Victorian and Julian Periods.

The Victorian Period, or Paſchal Cycle, is made up of Cycles of the Moon and Sun, that is, 19 multiplied by 28, is 532 Years, and after that Period is compleated, not only new Moon and full returns to the ſame Day of the Month, but alſo the Day of the Month returns to the ſame Day of the Week, therefore the Dominical Letters, and moveable Feaſts return in the ſame order.

The Julian Period is of excellent uſe in Chronology.

The *Julian* Period is a greater Cycle, or Circle, made up of the Cycles of the Moon, Sun, and Indiction, that is, 19 multiplied by 28, is 532, and 532 multiplied by 15, is 1980

Old and new Styles.

(4) The old Style is the computation of time, according to the Settlement of *Julius Cæſar*: This Style is in uſe in *Great Britain*.

New Style is the new computation of time according to the Settlement of Pope *Gregory* XIII. This Style is uſed in moſt places beyond Sea.

7980 Years: It is of uſe for diſtinguiſhing of Times; of all paſt Events from the very Creation. Hence ſeveral Chronologers do endeavour to adjuſt all other Accounts of time, and conſequently all Tranſactions and Events, recorded in Hiſtory, to the *Julian* Period.

The Æra of Chriſt is generally receiv'd in *Chriſtendom*, or *Europe*.

There are ſeveral Epoch's, or Æra's, which were formerly made uſe of in the ſeveral parts of the World. That of principal concern to us Chriſtians is the Æra of Chriſt, or the common way of computing time from the Nativity of Chriſt; according to which this preſent Year is reckoned the 1734th from the Nativity of Chriſt, or rather from the firſt of *January* next following the Nativity of Chriſt.

The ſeveral Characters, whereby particular times are diſtinguiſhed one from another, are ſtiled either Cycles, or Periods, or Æra's. And theſe are either natural or inſtituted by Men.

To find the Golden number.

To find the Golden Number, add 1 to the Year of our Lord, and divide by 19, the Remainder is the Golden Number, but if nothing remain, then 19 is the Golden Number (5).

Find

Of the Golden Number.

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(5) The reaſon of adding 1 is, becauſe the Æra of Chriſt began in the ſecond Year of this Cycle.

Find the Golden Num. for the Years	1712 and	1734 and	1740
	1	1	1
	19) 1713 (90)	19) 1735 (91)	19) 1741 (91)
	171	171	171
	3	25	31
	0	19	19
The Gold. Num. are	3 and	6 and	12

To find the Epact.

To find the Epact, multiply the Golden Number of the propoſed Year by 11, and the Product will be the Epact, but if it exceed 30, divide by 30, and the Remainder will be the Epact. (6)

Find the Epact for the Years	1712 and	1734 and	1740
	1	1	1
	(19 1713 (90)	19) 1735 (91)	19) 1741 (91)
	171	171	171
	3	25	31
	0	19	19
The Gold. Num. are	3 and	6 and	12
	11	11	11
			12
			12
	30) (33 (1)	30) 66 (2)	30) 132 (4)
	30	60	120
The Epacts are	3 and	6 and	12

To know the Epact, in reſpect of the Gregorian *Account.*

(6) When the Golden Number is 19, there is always 1 added to the Epact. The time of one new Moon from another never exceeds 30 Days, ſo the Epact never exceeds 30, and alters every Year 11, and changeth the firſt of *March*, if we count *March* the firſt Month, but if we call *January* the firſt Month, the Epact changeth the firſt of *January*, as well as the Prime. The Rule given is in reſpect of the *Julian* account: When the *Julian* Epact is known, if

Of Leap-Year.

To know if it be Biſſextile or Leap-year, divide the propoſed Year by 4, the Remainder ſhews the Year after Leap-year; but if nothing remains, then that Year is a Leap-year.

```
Suppoſe the Year 4) 1734 (433 Leap Years in
     all            16
                    ——
                    13
                    12
                    ——
                    14
                    12
                    ——
therefore it is      2 Years after Leap Year.
```

Of the Cycle of Sun.

To find the Cycle of the Sun, add 9 to the Year of our Lord, and divide the Sum by 28, the Remainder ſhews the Cycle, but if nothing remains, that is the laſt Year of the Cycle. (7)

```
Suppoſe the Year   1734
                      9
                   ————
              28)  1743 (62
                   168
                   ————
                     63
                     56
                     ——
The Cycle is          7
```

We

Of the Cycle of the Sun.

greater than 11, ſubſtract 11 from it, if leſs, add 30 to it, and out of the Sum ſubſtract 11, and the Reſiduewill be the *Gregorian* Epact.

(7) The Reaſon of adding 9, is becauſe the Era of Chriſt

We have already ſhewn that the common ſolar Years conſiſts of 365 Days, and the Leap-year 366 Days; 365 divided by 7 makes 52 Weeks and 1 odd Day; if the Year had been only 52 Weeks, and no odd Days, all the Years would conſtantly begin on the ſame Day of the Week, and each Day of a Month would conſtantly fall upon the ſame Day of the Week; but becauſe there is one Day over, from thence it happens that on whatever Day of the Week the Year begins, it ends on the ſame Day, and the next Year begins with the following Day, but on Leap-year with the ſecond Day. As the Leap-year returns every fourth Year, and hath 2 Dominical Letters, their order does not return till 4 times 7, *viz.* 28 Years; hence ariſeth the Cycle of 28 Years, called the Cycle of the Sun.

Why it conſiſts of 28 Years.

Of the Sunday Letter and how to find it.

The 7 Days in the Week, in the Kalendar, are ezpreſſed by the firſt 7 Letters in the Alphabet, and one of them is a Dominical or Sunday-Letter. And to find that Letter the Rule is:

Firſt know whether the propoſed Year be a Leap-Year, as is before ſhewn; then add the given Year of our Lord, and all the Leap-years contained therein, and 4 the

L 2 Number

---

began in the tenth Year of this Cycle. The Cycle of the Sun is improperly ſo called, foraſmuch as it relates not to the Courſe of the Sun, but to the Courſe of the Dominical or Sunday-letter; whence it ought to be called the Cycle of the Sunday-letter.

Number by which the Leap-years are found all together, and their Sum divide by 7, and the Remainder ſubſtract from 7, what is then left ſhews the Dominical or Sunday Letter.(8)

Find the Sunday Letter for the Years 1712 and 1734.

```
            1712 A Leap Year              2734
4) 1712 (428 Leap Year       4) 1734 ( 433
   16     4                     16      4
   —                            —
   11    ——                     13     ——
    8  7) 2144 (306             12  7) 2171 (31
   —      21                    —      21
   32    ——                     14     ——
   32     44                    12      7
   —      42                    —       7
    0     —                      2     —
           2                            1
           7                            7
          —                            —
FE anſwering to 5             F anſwering to 6
```

For the Year 1712 we find the Sunday-Letter muſt be the 5th of the Alphabet which is E, and we find it is a Leap-year, E is the laſt Letter, and F the firſt according to the given rule. We alſo find the Year 1734 produces 6, ſo the Sunday-letter muſt be F only, as it is not a Leap-year. And ſo may any other be found.

In

Of the Sunday Letter.

(8) The Dominical or Sunday-Letter, goeth backward in a common Year one Letter, but in a Leap-year two Letters, as the Leap-year has two Dominical Letters, one ſerves from the firſt of *January* to the 25th of *February*, and the other from thence to the Year's end, and it is the ſecond Letter the Rule finds.

Having found the Sunday-letter according to the *Julian* account, the *Gregorian* Sunday-letter will be the third in a backward order from the *Julian*.

How to make a Table for finding the Sunday-letter.

In order to ſhorten the Work, I will make a Table of the Cycle of the Sun, whereby the Sunday-letter may readily be found; and ſhew the Method how the Table is made.

As the Æra of Chriſt began in the tenth Year of the Cycle of the Sun, which conſiſts of 28 Years; the laſt of thoſe 28 Years muſt have been in the 19th Year of Chriſt. Therefore, according to the laſt given Rule, find the Dominical or Sunday-letter for the Year of our Lord 19. (9)

19 given Year is not a Leap-year.
4) 19 (4 all the Leap-years therein.
16 4 the Diviſor.
—
after the Leap-year 3 —
7) 27 (3
21
—
6
7
—
A anſwers to 1

N. B. By finding the Cycle of the Sun for any Year, as before ſhewn, againſt that Number in the Table is the Sunday-letter.

1 GF	5 BA	9 DC	13 FE	17 AG	21 CB	25 ED
2 E	6 G	10 B	14 D	18 F	22 A	26 C
3 D	7 F	11 A	15 C	19 E	23 G	27 B
4 C	8 E	12 G	16 B	20 D	24 F	28 A

To

To make the Table.

(9) Having placed the Numbers in the Table from 1 to 28, the Cycle of the Sun; and having found the Sunday-letter for

To find the moveable Feaſts. (10) To find the moveable Feaſts, firſt find the change of the Moon in *February* (or if the Moon change not in *February*, then take the next change after) and the next *Tueſday* after is *Shrove-Tueſday*, but if the Moon change on *Tueſday*, then the next *Tueſday* following is *Shrove-Tueſday*; then the next *Sunday* is the firſt *Sunday* in *Lent*; ſix *Sundays* after is *Eaſter-Day*, to which add five Weeks, ſo have you *Rogation-Sunday*; then it is four Days more to *Aſcenſion-day*; and ten Days after is *Whit-Sunday*; and the next Sunday after is *Trinity-Sunday*; and the next *Thurſday* is *Corpus-Chriſti* Day.

To find the Indiction. The *Roman* Indiction is found by adding 3 to the propoſed Year, and dividing the Sum by 15, the Remainder ſhews the Indiction, if nothing remains, then that is the laſt Year of the Indiction. (11)

Suppoſe

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for the Year of our Lord 19, (which was the laſt Year of the firſt Cycle) to be A, therefore I place A to 28, B to 27, C to 26, and as every fourth Year is a Leap-year, place DE to 25, and ſo for all the reſt.

Of the moveable Feaſts. (10) As the moveable Feaſts chiefly depend upon the change of the Moon, I will hereafter fully ſhew how to find the Change of the Moon in any Month in any Year.

Of the Indiction. (11) The Reaſon of adding 3, is becauſe the Æra of Chriſt began in the fourth Year of the Indiction.

Suppoſe the Year 1734
3
15)1737(115
15
23
15
87
75
The Indiction is 12

To find the Victorian Period.

The *Victorian* Period is found by adding 457, to the propoſed Year, and dividing the Sum by 532, and the Remainder ſhews the *Victorian* Period ſought.

(12) Suppoſe the Year of our Lord 1734
457
532(2191(4
2128
The *Victorian* Period is 63

To

Of the Victorian Period.

(12) The Reaſon of adding 457, is becauſe ſo many Years of the Period were expired before the firſt Year of Chriſt. The principal Reaſon of taking notice of the Indiction, and Victorian Period, is becauſe they conduce to the underſtanding of the *Julian* Period, next explained.

To find the *Julian* Period. To find what Year of the *Julian* Period any given Year of Chriſt anſwers to; to the given Year add 4713, the Sum is the Anſwer. (13) For inſtance,

Suppoſe the Year of our Lord	1734
	4713
The Year ſought of the *Julian* Period is	6447

To find the Year of Chriſt. Having the Year of the *Julian* Period given to find what year of Chriſt anſwers thereto; from the given Year ſubſtract 4713, and the Reſidue will be the Year of Chriſt ſought. (14) For inſtance,

Suppoſe the Year of the *Julian* Period	6447
	4713
The Year ſought is the Year of our Lord	1734

If the Year of the *Julian* Period given be 4713, or leſs than it, then ſubſtract the ſame from 4714, which is the Year of the *Julian* Period, that anſwers to the firſt Year of Chriſt, and the Reſidue will ſhew, how long after the firſt Year of Chriſt, the given Year of the *Julian* Period was.

For

Of the Julian *Period.* (13) (14) The Reaſon of adding and ſubſtracting 4713, is becauſe ſo many Years of the *Julian* period were expired before the firſt Year of Chriſt. This Period began 764 Years before the Creation, and is not yet compleated, and therefore it comprehends all other Periods, Cycles and Epoches, and the time of all memorable Actions and Hiſtories.

To find how many Years before Chriſt *Rome* was built.

For inſtance, the City of *Rome* is ſaid to have been built *J.P.* 3960. I would know therefore, how long it was built before Chriſt.

4714
3960

Wherefore *Rome* was built 757 Years before the Æra of Chriſt.

To find how many Years before Chriſt was the Deſtruction of *Troy*.

The Deſtruction of *Troy* is computed to fall in with *Julian* Period 3531, how long was it before Chriſt?

4714
3531

The Deſtruction of *Troy* was 1183 Years before Chriſt.

To find the Cycle of the Sun, Moon, or Indiction.

To know what Year of the Cycle of the Sun, Moon, or Indiction, anſwers to any Year given of the Julian Period; divide the given Year reſpectively by 28, or 19, or 15, the Remainders will ſhew the Years of the Cycles reſpectively. If nothing remains in each Diviſion, then it is the laſt Year of each Cycle reſpectively. For inſtance,

Suppoſe the Year of the Julian Period 6447

28) 6447 (230	19) 6447 (339	15) 6447 (429
56	57	60
84	74	44
84	57	30
07	177	147
00	171	135
(15) 7 Cycle of the Sun.	6 Cyc. of Moon.	12 Indict.

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(15) Here we find that in the 6447 Years of the *Julian* *The ſeve-*

and the contrary. On the contrary, to know what Year of the *Julian* Period anſwers to any given Year of the Cycle of the Sun, or Moon, or Indiction; multiply the Cycle of the Sun into 4845. And multiply the Cycle of the Moon into 4200. And multiply the Cycle of the Indiction into 6916. The Sum of the Products being divided by 7980, the Remainder will ſhew the Year of the *Julian* Period ſought. For inſtance,

Suppoſe 7 Cycle of Sun.	6 Cycle of M.	12 the In.
4845	4200	6916
33915	25200	13832
25200		6916
82992		82992

7980) 142107 (17
7980
62307
55860

therefore 6447 is the Year of the *Julian* Period as before.

To

ral Queſtions propoſed, are rightly anſwered. Period, the Cycle of the Sun is 7, the Cycle of the Moon or Golden Number is 6, and the Indiction is 12, and by the ſeveral foregoing Inſtances, we have found that the 6447 Year of the *Julian* Period anſwers to this preſent Year 1734. And alſo that the Cycles of the Sun, Moon, and Indiction are 7, 6 and 12, this preſent Year 1734. Therefore the ſeveral Inſtances and Examples prove one another to be rightly done.

The reaſon of the fixed Numbers. *Note*, The numbers 4845 and 4200 and 6916, may be ſound, by finding three Numbers, ſuch as the firſt is a Multiple of 19 and 15, or of their Product 285, being divided by 28, leaves the Number of the Cycle of the Sun; the ſecond muſt be a Multiple of 28 and 15 or of their Product 420, but being divided by 19 leaves the Cycle of the Moon; the

To find the New Moon.

To find what Day of any Month, in any Year, the new Moon falls on: to the Number of the Month from *March* incluſively, add the Epact of the Year given; if the Sun be leſs than 30, ſubſtract it out of 30; if greater, ſubſtract it out of 60; and the Remainder will be the Change Day. *N.B.* When the Number of the Months from *March* incluſive exceeds ten, then ſubſtract ten, and work by the Remainder.

Find the Change Days in *April*, *May*, and *September*, in the Year } 1734

1

19) 1735 (91

171

25

19

Golden Num. 6

11

30) 66 (2

60

Epact 6

April	2	*May*	3	*September*	7
	6		6		6
	8		9		13
	30		30		30
(16)					
New Moon	22	New Moon	21	New Moon	17

the third muſt be a Multiple of 28 and 19, or of their Product 532, but being divided by 15 leaves the Indiction; the Sum of theſe three Numbers if leſs than 7980, is the Year of

To find the Moon's ſouthing.

To find the Moon's ſouthing, or time o her coming to the Meridian, multiply th Day of the Moon's Age by 48, and divid the Product by 60, the Quotient gives th Hours, and the Remainder is the Minutes, ſo have we the time of the Moon's coming te the Meridian. (17)

If the Moon be 12 Days old, when will ſhe be upon the Meridian

48
—
96
48
— *h. m.*
60) 576 (9 36 in the Afternoon.
504
—
36

The Moon 25 Days old, when will ſhe be ſouth or upon th Meridian. 4
— *h. m.*
5) 100 (20 00
10 12 00
— —
0 8 00 in the Morning.

If

---

of the *Julian* Period. But if the Sum be bigger, divide by 7980, and the Remainder will be the Period. Or by con- ſtant and ſtated Multiplicators, the firſt of which is a Mul- tiple of 285, divided by 28, leaves one; the 2d a Multipl of 420, divided by 19, leaves one; the 3d a Multiple o 532, divided by 15, leaves one. And the numbers 4845, 4200, 6916, being once found, the Canon or Rule is as ſhew in the Queſtion.

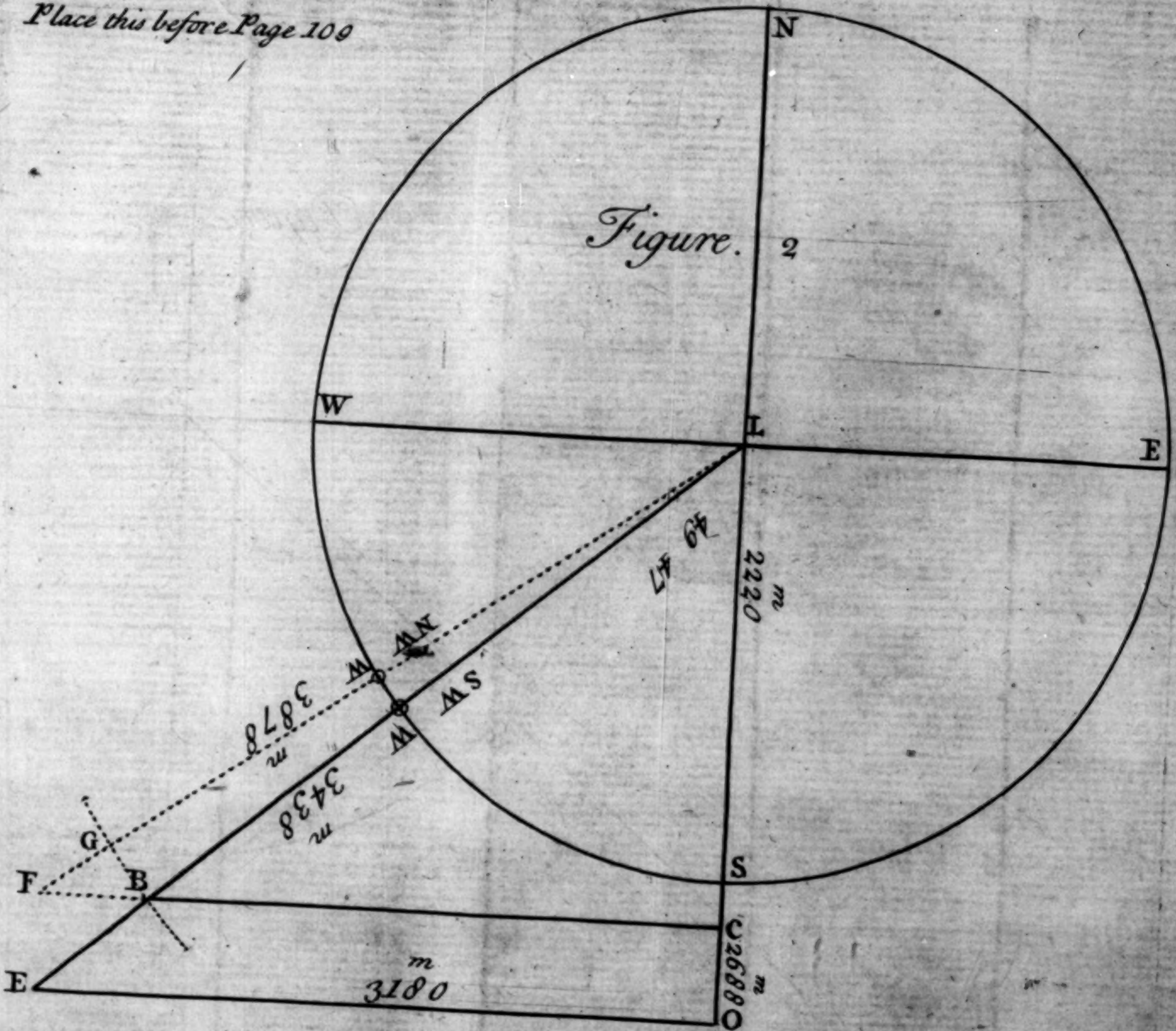
To find the Moon's Age.

(16) In the former Queſtions are ſhewn how to find th Golden Number and the Epact, though they happen to b both the ſame Number this Year, it doth not often happen ſo. As the Moon's age never exceeds 30 Days, when th Change Day is found, her Age at any time may eaſily b known by counting from the Change.

Of the Moon's ſouthing.

(17) The reaſon we multiply by 48, is becauſe th Moon comes every Night, one with another, 48 Minut lat

Place this before Page 109



If ſhe be 17 Days old, when will ſhe be at the Meridian,

```
       4
     ———
5)   68     ( h    m
      5      13——36
     ———     12——00
     18     ————————
     15       1——36 in the Morning.
     ———
      3
     12
     ———
     36
```

To find the Time of High Water.

To find the Time of Full Sea, or High-Vater, at any Place.

Firſt, We find by the Tide-Table, or our wn Experience, what Moon makes High-Vater in that Harbour on the Change-Day. 'o the Moon's Southing, add the Time of Iigh-Water on the Full and Change Day, or the Place propoſed: The Sum is the 'ime required. And if we know the Time f High-Water in a Harbour at any Time, hen ſubſtract the Moon's Southing from hat Time and the Remainder is the Time f High-Water in that Harbour, on the Full r Change Day.

Suppoſe it be High-Water at *London* at Three o' Clock on the Full or Change-Day, when

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er to the Meridian, and we divide by 60, to bring thoſe inutes into Hours. But to ſhorten the Work we may ltiply by 4, and divide by 5; and for every one that re-ains count 12, which wiil come to the ſame. When the oon is in her Increaſe ſhe is upon the Meridian before idnight, but when in her Decreaſe, it is after Midnight, before ſhewn.

when will it be High-Water in that Place, *May* the 26th, 1734.

		1		
	19)	1735 (91		
		171		
		25		
		19		
Golden Numb.		6		
		11		
	30)	66 (2		
		60		
The Epact		6		
Numb. of Months		3		
		9		
		30		
Change Day.		21		
Given Day.		26		
Moon's Age.		5		
		4		
	5)		h.	m.
		20	4	00
		20	3	00
		0		
We find the Moon is South at 4 o' Clock, and High-Water at 7 o' Clock.			7	00

Suppoſe we come into that Harbour and find it to be High-Water at 7 o' Clock, and the Moon to be South or upon the Meridian at 4 o' Clock; when will it be High-Water on the Full or Change Day?

	h.	*m.*
	7	00
	4	00
(19) Therefore it muſt be High Water on the Change-Dat at	3	00

Of the former Rules.

To find the Time of High-Water.

Suppoſe it be found by Experience that it is High-Water at *Hull* at Six o' Clock on the Full or Change-Day; when will it be High-Water in that Part, *May* 20, 1735.

1735
1
―――
19)1736 (91
171
―――
26
19
―――
Golden Number 7
11
―――
30) 77 (2
60
―――
The Epact. 17

---

(19) In the former Queſtions and Rules, we have ſhewn how to find the Golden Number, Epact, Number of Months, Change Day, and Age of the Moon, and her Southing.

Number

Number of Month	3		
	20		
	30		
Change Day.	10		
Given Day.	20		
Moon's Age.	10		
	4	h.	m.
	5) 40	(8	00
	40	6	00
	(0)		
		14	00
		12	00
We find the Moon is South at 8 o' Clock in the Morning, and it will be High-Water at 2 o' Clock in the Afternoon.		2	00

Suppoſe we come into that Harbour, and find it to be High-Water at 2 o' Clock, and the Moon to be South, or upon the Meridian at 8 o' Clock; when will it be High-Water on the Full or Change Day?

h.	*m.*
2	00
12	00
14	00
8	00

(21) Therefore it muſt be High-Water on the Change-Day at —— } 6 00

Having in this fourth and laſt Partition explained the moſt uſeful Elements of Chronology, and ſhewn how to find all the Particulars generally taken notice of in the Almanacks; I proceed now to ſolve the moſt uſeful Problems in Navigation and Aſtronomy, and ſhew how to find the Variation of the magnetical Compaſs, and the Latitude by Obſervation.

Of the High-Water.

(21) Here we find the Epact differs from the GoldenNumber, and that it alſo differs or alters 11 from the laſt Year, as before explained. When the Moon's Southing and Time of High-Water on the Change-Day exceeds 12, ſubſtract 12, as in the former Queſtion, where it is High-Water at Two o' Clock in the Afternoon; for it is more proper to ſay 2 o' Clock than 14 o' Clock: And likewiſe when the Time of High-Water is leſs than the Moon's Southing, add 12, and then ſubſtract, as in the laſt Queſtion.

Of the Tides.

It appears by the ſeveral Inſtances here explained, that the Tides are chiefly govern'd by the Moon.

Practical Geometry, Trignometry, and Sa ing, according to the ſeveral Charts, a taught in all the common Epitomes or Boo of Navigation. Nevertheleſs, I percei there are ſeveral Teachers, as well as Se faring-men, which hath not a true Notic of the Art of Navigation.

Therefore I will compare and explain th ſeveral Sorts of Sailing, and demonſtra them by Geometry, and the Aſſimil and then work all the uſeful aſtronomic Problems, demonſtrate them by the Aſſimil according to both Syſtems, and explain th Variation of the Compaſs, and taking Obſe tions, remonſtrate them by the Aſſimilo.

Let us find a Ship's Way from the *Lizar* in *Great Britain*; to the Iſland of *Barb does*, according to the plain Mercator middle Latitude, and great Circle-Sailing.

		d.	m.				
Lizard,	Lat.	50	00N	Mer. Pts.	3475	Long	05.00W
Barbad.		13	00N		787		58.00W
Their Diff.		37	00 S.		2628		53.00W
		60					60
In Miles		2220					3180
Sum of Lat. is		63	00				
Half Sum is		31	30	The Middle Latitude.			
Half Difference is		18	30				

What is the Courſe and Diſtance from th *Lizard*, to *Barbadoes*, according to Plain-ſailing;

Place this before Page 107.

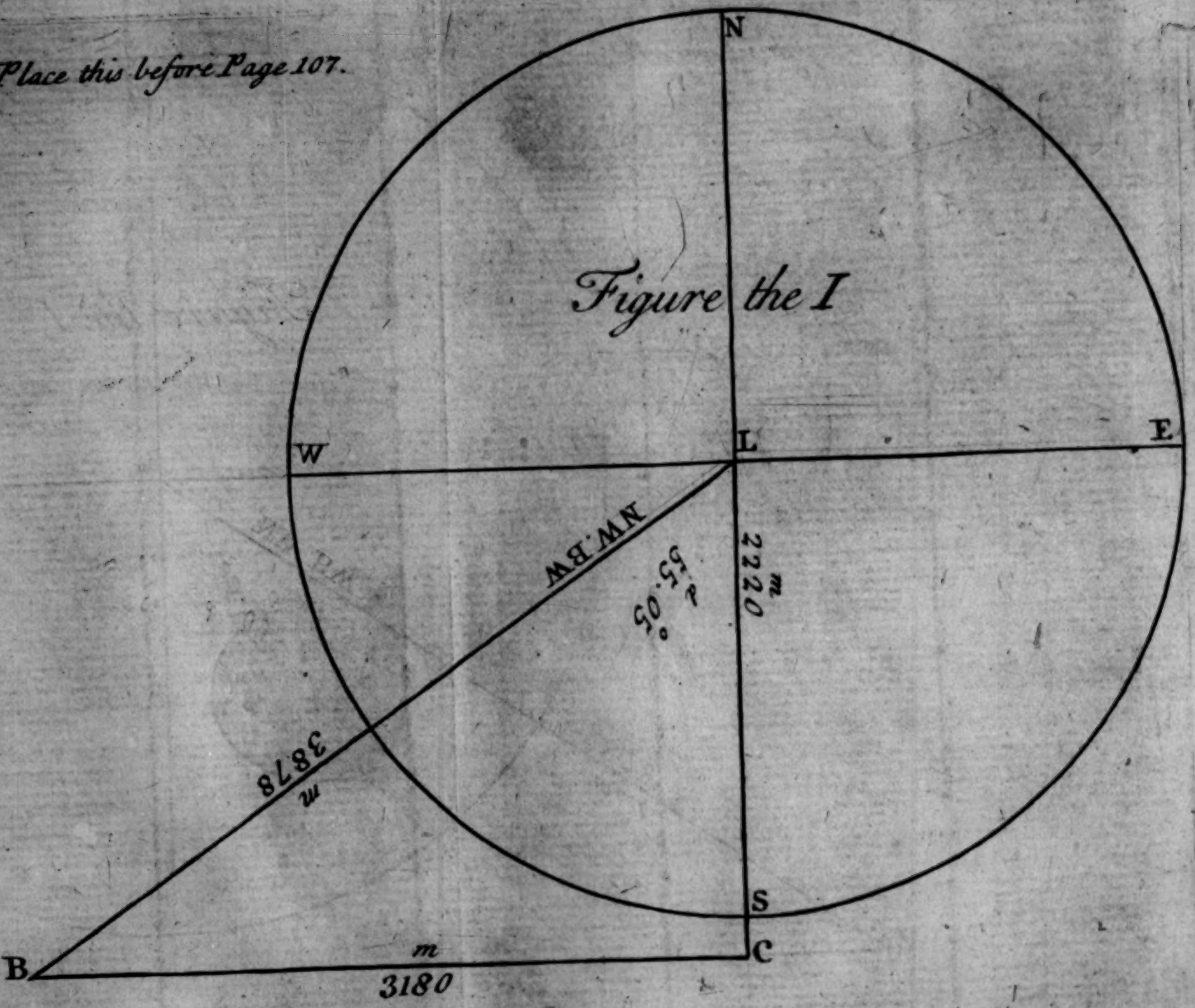

Figure the I

ıiling: Their Latitude and Longitude
eing given as before. (2)

The PROPORTIONS.

	M.	
s Diff. Lat. L. C.	2220	3 : 346353
	d. m.	
to the Radius Tang.	45. 00	10 : 000000
Diff. Long. B. C.	*M.*	
	3180	3 : 502427
	d. m.	
o Tangent of the Courſe B.L.C.	55. 05	10 : 156074
	d. m.	
s Sine of the Courſe B. L. C.	55. 05	9 : 913806
	M.	
to Diff. Long. B. C.	3180	3 : 502427
	d. m.	
is Radius Sine.	90. 00	10 : 000000
o the Diſtance L. B.	3878	3 : 588621

The Courſe is 55 d. 05 m. or N.W.B.W.
eareſt, and Diſtance is 3878 Miles.

If a Ship ſails from the *Lizard* in Lati-
ıde 50 d. 00 m. N. and Longitude 5 d.
o m. W. and makes her Courſe (when Va-
ation, Lee-way, *&c.* allowed for) to be
5 d. 05 m. from the South towards the Weſt,
iz. N.W.B.W. neareſt, and her Diſtance

Plain. Sailing.

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(2) With the Chord of 60, or Sine of 90 make the Circle
.N.E.S. Fig. 1. which denotes Weſt, North, Eaſt and
uth; from any Scale of equal Parts take 2220 m. and
y it from L. which repreſents the *Lizard* to C. at C, erect
Perpendicular, as C. B. from the ſame Scale of equal
arts, take 3180 m. and lay it from C. to B, which repre-
nts *Barbadoes*: Then draw the Line to B. the Diſtance,
hich meaſured on the ſame Scale, the Difference of Lati-
ıde and Longitude was taken from, and it is 3818 m.
here that Line cuts the Circle, meaſured from S. upon
e Line of Chords, is 55 d. 05. or N.W.B.W. neareſt
e Courſe.

Plain Sailing. The Geometrical Projection.

ſailed 3878 Miles, find the Latitude and Longitude ſhe is then in. (3)

The PROPORTIONS.

	d. m.	
As Radius Angle L. C. B.	90 00	10,000000
	M.	
To Diſtance run L. B.	3878	3. 588621
	d m.	
So Sine of the Courſe B.L.C.	55 05	9. 913806
	60) *M.*	
To Diff. Long. B. C.	3180	3. 502427
Which is equal to	53 00	Diff. Long. Weſt,
The *Lizard's* Longitude	5 00	Weſt,
Their Sum is	58 00	Long. the Ship was in W.
	d. m.	
As Radius Angle L. C. B.	90 00	10.000000
To Diſtance run L. B.	3878	3. 588021
	d. m.	
So Sine Comp. of the Courſe.	55 05	9. 757688
	60) *M.*	
To Diff. Lat. L. C.	2220	3. 346309
Which is equal to	37 00	Diff. Lat. South.
The *Lizard's* Latitude	50 00	North.
Their Difference is	13 00	Lat. the Ship is in N.

The Ship is then in the Latitude of 13 d. 00 m. North, and Longitude 58 d. 00 m. Weſt; therefore ſhe muſt be at *Barbadoes* as before.

Plain. Sailing. The Geometrical Projection.

(3) In Fig. 1. lay 55. d. 05 m. the Courſe from S. to N.W.B.W. on the Circle taken from the Line of Chords, then draw the Line L B, and on it lay 3878 m. the Diſtance ſail'd, taken from the Scale of equal Parts, from B. let fall a Perpendicular, upon the Meridian, as at C; then the Lines B. C. and L. C. meaſured on the Scale of equal Parts is 3180. m. and 2220 m.

This and the laſt Queſtion proves each other to be rightly done.

Mercator's Sailing.

What is the Courſe and Diſtance from the *Lizard* to *Barbadoes*, according to *Mercator*'s Sailing; their Latitude and Longitude being given as before in Plain-Sailing. (4)

The PROPORTIONS.

As Merid. Diff. Lat. L. D.	M. 2688	3. 429429
To the Radius Tang.	d. m. 45.00	10. 000000
So Diff. Long. D. E.	M. 3180	3. 502427
To Tangent of the Courſe E.L.D.	49.47	10. 072998
As Sine of the Courſe B. L. C.	d. m. 49.47	9. 810017
To proper Diff. Lat. L. C.	M. 2220	3. 346353
So Radius Sine.	d. m. 90.00	10. 000000
To the Diſtance L. B.	3438	3. 536336

The Courſe is 49 d. 47 m. or S.W. half W. neareſt and Diſtance 3438 m. Miles.

Mercator's Sailing.

Suppoſe a Ship ſails from the *Lizard* in Latitude 50 d. 00 m. N. and Longitude 5 d. 00 m. W. and makes her Courſe (when Va-

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Mercator's *Sailing*

The Geometrical Projection.

(4) From L (repreſenting the *Lizard*) Fig. 2d. lay 2688 m. (the Meridional Diff. Lat.) to D Southerly from L draw DE Perpendicular to LD, and thereon lay 3180 m. Diff. Long. from D to E, Weſterly from D; from L to E draw a Line which concludes the Triangle ELD; and the Angle ELD which is the Angle at L, meaſured on the Scale of Chords is 49 d. 47 m. the Courſe; then upon the Meridian make to C, equal to 2220 m. (proper Diff. Lat.) and draw CB parallel to DE to Lat. LE in B, and LB meaſured on the ſame Scale LC was taken from is 3438 m. the Diſtance.

riation,

Mercator's Sailing.

riation, Lee-way, *&c.* allow'd for) to 49 d. 47 m. from the South towards t Weſt, *viz.* S.W. half S. neareſt, and t Diſtance ſailed 3438 Miles, what Latitu and Longitude is ſhe then in. (4)

The PROPORTIONS.

	d. m.		
As Radius Sine L.C.B.	90.00	10.000000	
To Diſtance ſailed L.B.	34.38	3.536336	
So Sine Comp. of Courſe	49.47	9.810017	
	60)		
To Prop. Diff. Lat. L.C.	22.20	3.346353	
Which is equal to	37.00 S.		
Latitude of the *Lizard.*	50.00 N.	Merid. Parts.	34
Lat. the Ship is then in.	13.00 N.	Merid. Parts.	7
The Merid. Diff. of Latitude.			26
As Radius Tangent of	45.00	10.000000	
To Merid. Diff. Lat. L.D.	26.88	3.429429	
So Tangent of the Courſe E.L.D.	49.47	10.072298	
	60)		
To Diff. Long. D.E.	31.80	3.502427	
Which is equal to	53.00 W.		
Longitude of the *Lizard.*	5.00 W.		
Longitude the Ship is then in.	58.00 W.		

(4) In Fig. 2. the Difference between Plain and *Mercator* Sailing is demonſtrated, as well as proved by the ſeveral Operations; for the Triangle LCF in Fig. 2, is made equal to the Triangle LCB in Fig. 1. in every Reſpect, and L. repreſents the *Lizard*, and B. *Barbadoes* in both Fig. 1. and 2. therefore the Courſe in Fig. 1. is more Weſt than in Fig. 2. as much as between O and O, *viz.* 5 d. 18 m. as by the Operations, and the Diſtance in Fig. 1. is more than the Diſtance in Fig. 2. as much as between G and F, *viz.* 440 m. as by the Operations. In Plain-Sailing, CF repreſents both Diff. Long. and Departure from the Meridian: In *Mercator*'s Sailing DE equal to CF repreſents the Diff. Long. and CB the Departure from the Meridian; therefore the Difference between Longitude and Departure is as much as between B and F.

Mercato *Sailing.*

The Geo-metrical Projecti

The Dif between Plain a Mercato *Sailing d monſtrat-ed.*

The

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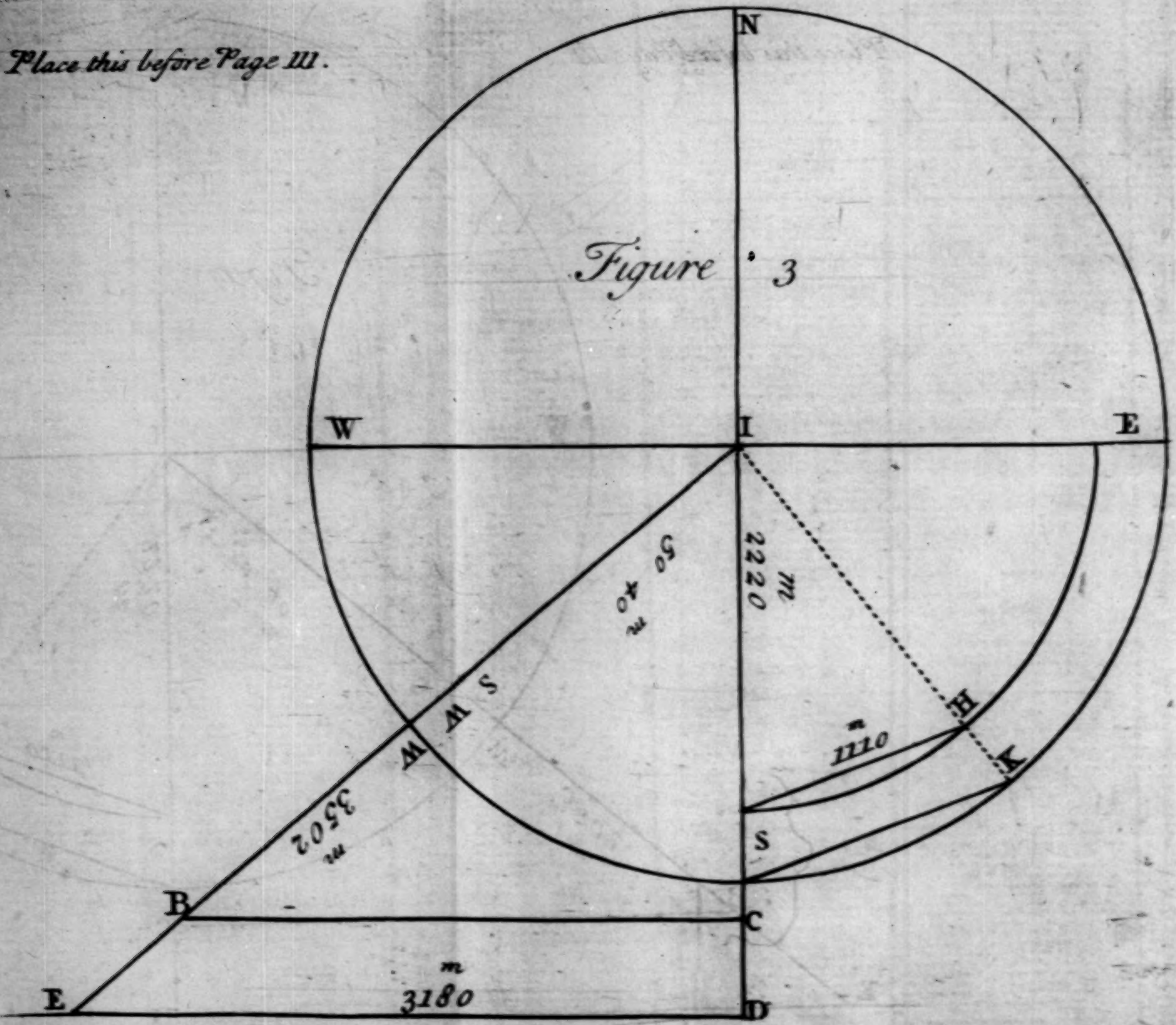

Figure 3

The Ship is then in the Latitude of 13d. 0 m. N. Longitude, 58 d. 00 W.

Therefore ſhe muſt be at *Barbadoes* as be- re.

This and the laſt Queſtion proves each her to be rightly done.

	d. m.	Miles.
ccording to Plain-Sailing the Courſe is ———	55.05	Diſt. 3878
ccording to *Mercator's* Sailing, the Courſe is	49.47	Diſt. 3438
The Difference is —	5.18	440

What is the Courſe and Diſtance from e *Lizard* to *Barbadoes*, according to Midle Latitude Sailing; their Lat. and Long. eing given as before in Plain-Sailing. (5) Sailing by the Middle Latit.

The PROPORTIONS.

	M.	
Diff. Lat. L.C.	2220	3.346353
	3180	3.502427
o Diff. Long. DE.	d. m.	
	31.30	9.930760
Sine Comp. of Merid. Lat.		
		13.433187
	d. m.	
o Tang. of the Courſe.	50.40	10.086834

Sine Comp. of the Courſe.	50.40	9.801973
o Diff. Lat. L.C.	2220	3.346353
Radius	90.00	10.000000
o Diſtance L.B.	3502	3.544380

MakeLC upon theMerid Fig. 3. equal toDiff. Lat. 2220m. e Circle W.N.E.S. be drawn with the Chord of 60, or e of 90 as before directed) with the Sine Complement of e Mid. Lat. 31 d. 30 m. taken of Sines, draw the Arch H, and on it lay half the Diff. Lat. 1110m. from G to H, d byL and H draw a Line to cut the Circle in K; lay SR ice on the Meridian from L to D, on D erect a Perpendiar, and thereon lay the Diff. Long. 3180 m. from D to E, *Sailing by the Middle Latit. The Geometrical Projection.*

Tho

The Courſe is 50 d. 40m. or S.W. W. and Diſtance 3502 Miles.

Sailing by the Middle Latitude.

Suppoſe a Ship ſails from the *Lizar* Latitude 50 d. 00 N. and Longitude 00m. N. and makes her Courſe (when riation, Lee-way, *&c.* allowed for) to 50 d. 40m. from the South towards Weſt, *viz.* S.W. half W. and her Diſta ſailed 3502 m. what Latitude and Lon tude is the Ship in then. (6) T

The PROPORTIONS.

		d. m.	
As Radius		90.00	10.000000
To Diſtance ſailed L.B.		3502	3.544380
So Sine Comp. of the Courſe BLD		50.40	9.801973
	60)		
To Diff. Lat. L.C.		2220	3.346353
Which is equal to		37.60 S.	
Latitude of *Lizard* is		50.00 N.	
Latitude the Ship is then in is		13.00 N.	
As Sine Comp. of the Mid. Lat.		31.30	9.930760
To Tangent of the Courſe		50.40	10.086834
So Diff. Lat. L.C.		2220	3.346353
			13.433187
	60)		
To Diff. Long. D.E.		3180	3.502427
Which is equal to		53.00 W.	
Longitude of the *Lizard* is		5.00 W.	
Longitude the Ship is then in		58.00 W.	

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and draw a Line from L to E and from C draw C B Para to D E to cut L E in B, then L repreſents the *Li* and B *Barbadoes*: Then from S to S W half W, mea upon Chords is 50 d. 40 m. the Courſe, and L B mea on the Line of equal Parts, that the Diff. Lat. and half Lat. and Diff. Long. was taken from is 3502 the Diſta

Sailing by the Middle Latitude.

(6) Lay the Courſe 50 d. 40m. from S. to S.W. half Fig. 3, and draw the Line S.W. half W. 3502m. to B, fr

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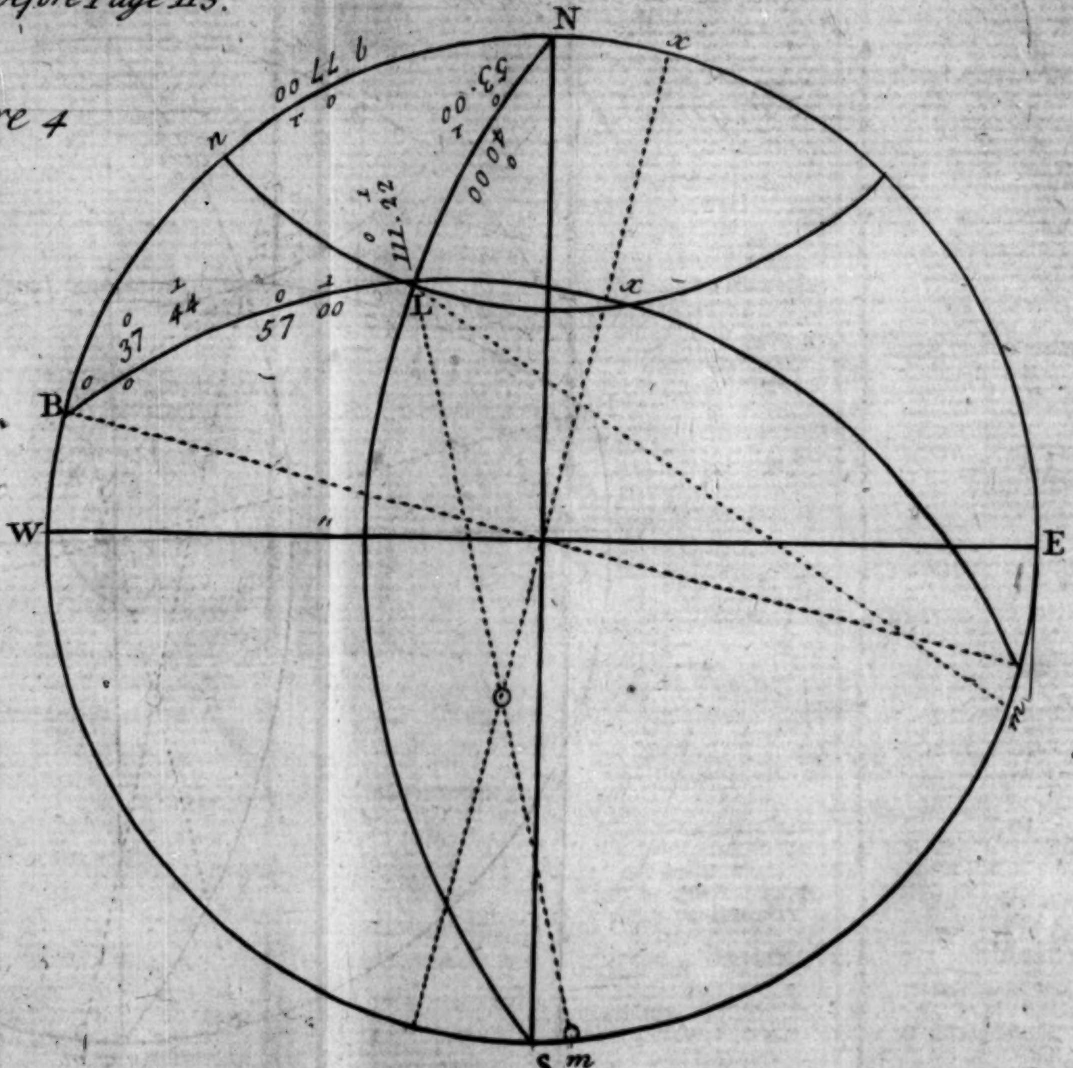
Figure 4



The Ship is then in the Latitude of 13 d. oo m. N. and Longitude 58 d. oo m. W. therefore ſhe muſt be at *Barbadoes* as before.

This and the laſt Queſtion proves each other to be rightly done.

	d. m.	
According to *Mercator*'s Sailing the Courſe is	49.47	Diſt. 3438
According to Middle Lat. Sailing the Courſe is	50.40	Diſt. 3502
he Difference is	00.53	64

The Difference is very ſmall, therefore Middle Latitude nearly agrees with *Mer-ator*'s Sailing.

Great Circle Sailing.

What are the Angles of Poſition, and the Diſtance of *Barbadoes* from the *Lizard*, according to Great Circle-Sailing; their Latiudes and Longitudes being given as before n Plain-Sailing. (7)

---

t fall a Perpendicular upon the Meridian as at C, then L C eaſured on the ſame Scale, the Diſtance ſailed was taken om is 2220 m. then lay half of 2220 on the leſſer Arch nade as before directed) from G to H, by LH draw a Line cut the Circle in K, lay twice DS on the Meridian from to D, and there erect a Perpendicular to cut the S.W half Line in E, and DE meaſured on the Scale of equal Parts 3180 m. the Diff. Long and CB is the Departure from e Meridian NB as GH is half L C; ſo is CK half LD, and of any other. See Fig. 3.

Great Circle Sailing. The Geometrtical Projection.

(7) Having deſcribed the primitive Circle W.N.E.S. as efore, (by Spherical Geometry) make the Angle B.N.L. qual to 53 d. oo m. the Diſt. Long. the Side NB 77. d. o m. the Complement of the Lat. of *Barbadoes*, N L o d. oo m. Complement of the Lat. of the *Lizard*. Then s the Angle at N is meaſured from W to w on the Scale f hhlf Tangents from 90 backward, and is 53 d. oo m, ſo

The PROPORTIONS.

	d. m.		d. m.
The Side NB	77.00	Angle BNL	53.00
The Side NL.	40.00	Half BNL	26.30
Sum of Sides	117.00		
Diff. of Sides	37.00		
Half Sum	58.30		
Half Diff.	18.30		

Then,	d. m.	
As Sine	58.30	9.930760
To Sine	18.30	9.501476
So Tang. Comp.	26.30	10.302264
		19.803740
To Tangent	36.44	9.872980

And again,	d. m.	
As Sine Comp.	58.30	9.718085

the Angle at B may be meaſured on the right Circle from X to X, and is 37 d. 44 m. by the ſame Scale, and the Angle at L being reduced to the primitive Circle, m m meaſured on Chords is 68 d 38 m. its Comp. to 180 d. 00 m. is 111 d. 22 m. the Angle at L, and the Side L B reduced to the primitive Circle is meaſured from B to b on Chords, and is 57 d. 00 m. and ſo N L from N to n 40 d. 00 m. and N B 77 d. 00 m. being the primitive Circle needs not be reduced.

To

To Sine Comp.	18.30	9.976957
So Tang. Comp.	26.30	10.302264
		20.279221
To Tangent	74.38	10.561136
To it add	36.44	
The Sum is the greater Angle NLB	111.22	
Being ſubſtracted is the leſſer Ang. NBL	37.44	
And then	*d. m.*	
As Sine of the Ang. NBL	37.44	9.786742
Is to Sine of the Side NL	40.00	9.808067
So is Sine of Angle BNL	53.00	9.902349
		19.710416
To Sine of the Side BL	57.00 60	9.923674
Which is equal to	3420 Miles,	

The Angle of Poſition at L, which repreſents the *Lizard* is 111 d. 22 m. and the Angle of Poſition at B, which repreſents *Barbadoes*, is 37d. 44m. and the Side LB their Diſt. in the Arch of a great Circle is 3420.

Great Circle Sailing by the Globe.

To anſwer thoſe by the Globe, the Terreſtrial Globe being properly fixed in its Frame, *viz.* put it upon its Axis and the braſs Meridian on which the little hour Circle and Index are fixed, and place it in the little Frame made for that Purpoſe; then lay the beginning of the graduaed Edge of the Quadrant of Altitude to the *Lizard*, juſt under the Braſs Meridian, and continue it to *Barbadoes*, there being intercepted between them 57 d. 00 m. which is their Diſtance LB, and the ſaid Quadrant cuts the Horizon in 68 d. 38 m. from South Weſtward, which is the Angle of Poſition (at the *Lizard*) of *Barbadoes* from it; that is the Angle, the Arch of a Great Circle paſſing over the two Places makes what the Meridian of the *Lizard*, as the Angle BLS, and if we begin at *Barbadoes*, rectify the Globe as before, their Diſtance BL is 57 d. 00 m. as before; but the Quadrant cuts the Horizon in 37d. 44m. from North-Eaſtward, the Angle of Poſition of the *Lizard* from *Barbadoes*, as the Angle LBN.

Great Circle Sailing.

Suppoſe the Angle of Poſition at the *Lizard* be 111 d. 22 m. and the Angle of Poſition at *Barbadoes* be 37 d. 44 m. and the Diſtance between the *Lizard* and *Barbadoes* be 57 d. 00 m. or 3420 m. the *Lizard* being in Latit. of 50 d. 00 m. North, and Longitude of 5 d. 00 m. Weſt: What Latitude and Longitude is *Barbadoes* in (8.)

Great Circle Sailing. The Geometrical Projection.

(8) In Fig 4. (by Spherical Geometry) make the Angle BLN equal to 111 d. 22 m. and the Angle LBN equal to 37 d. 44 m. and the Side LB equal to 57 d. 00 m. then meaſure the Angle at N from W to w, on half Tangents backwards, is 53 d. 00 m. meaſure the Side NB on Chords, is 77 d. 00 m. reduce the Side NL to the Primitive Circle, and meaſure it from N to n is 40 d. 00 m. See Fig. 4. N repreſents the North Pole, L the *Lizard*, and B *Barbadoes*.

The

The Operations or Proportions.

			d. m.
The Ang. NLB	111.22	The Side LB	57.00
The Ang. NBL	37.44		
Their Sum	149.06	Half LB.	28.30.
Their Difference	73.38		
Half Sum	74.33		
Half Difference	36.49		

Then,	d. m.	
As Sine	74.33	9.984015
To *Sine*	36.49	9.777613
So Tang.	28.30	9.734764
		19.512377
To Tangent	18.30.	9.528362

And again,	d. m.	
As Sine Compl.	74.33	9.425530
To Sine Compl.	36.49	9.903392
So Tangent	28.30	9.734764
		19.638156
To Tangent	58.30	10.212626
To it add	18.30	

The Sum is the greater Side NB.	77.00	And is the Com. of 13 d. 00 N.
Subſtracted is the leſſer Side NL	40.00	the Latit. of *Barbadoes*,
And then	d. m.	
As the Sine of the Side NL	40.00	9.808067
Is to Sine of the Ang. NBL	37.44	9.786742
So is the Sine of the Side BL	57.00	9.923674
		19.710416
To the Sine of the Ang. BNL Diff. Long.	53.00	9.902349
The *Lizards* Longit. is	5.00 Weſt.	
Barbadoes is in Long. of	58.00 Weſt.	

This and the laſt Queſtion proves each other to be rightly done.

Great Circle Sailing by the Globe.

To anſwer theſe by the Globe, the Terreſtrial Globe being properly fixed in its Frame, bring *Barbadoes* juſt under the Braſs Meridian; and on the ſaid Meridian againſt it is 13 d. 00 m. N. Latitude, and the ſaid Meridian cuts the Equator in 58. d. 00 m. Weſtward from the Meridian of *London*; therefore *Barbadoes* is in the Latitude of 13 d. 00 m. North, and Longitudes of 58 d. 00 m. Weſt: As by the Operations.

If a Ship ſails from the *Lizard*, and her Courſe make an Angle of Poſition with the Meridian of 68 d. 38 m. South-Weſterly till her Diſtance ſail'd be 57 d. 00 m. what

Latitude and Longitude is ſhe then in? The Globe being rectified to the Latitude of the *Lizard*, fix the firſt Degree of the Quadrant to the *Lizard*, being under the Braſs Meridian, and let the Quadrant cut the Horizon in 68 d. 38 m. South-Weſt-ward; then is 57 d. om. upon the Quadrant, the Place where the Ship is; which brought to the Braſs Meridian ſheweth the Latitude 13 d. 00 m. North, and cuts the Equator in 58 d. 00 m. Weſt, the Longitude from the Meridian of *London*, and is *Barbadoes.*

If a Ship ſails from *Barbadoes* and makes an Angle of Poſition with the Meridian of 37 d. 44 m. North-Eaſterly till her Diſtance be 57 d. 00 m. what Latitude and Longitude is ſhe then in? The Globe being rectified to the Latitude of *Barbadoes*, ſix the firſt Degree of the Quadrant to *Barbadoes*, being under the Braſs Meridian, and let the Quadrant cut the Horizon in 37 d. 44 m. North-Eaſtward; then is 57 d. 00 m. upon the Quadrant, the Place where the Ship is; which brought to the Braſs Meridian ſheweth the Latitude of 50 d. 00 m. North; and cuts the Equator in 5 d. 00 Weſt, the Longitude from the Meridian of *London*, and is the *Lizard.*

By obſerving the foregoing Rules, any Queſtion of Navigation may be anſwered by the Globe, and will exactly agree with Great Circle Sailing. (9)

Of the ſeveral ſorts of Sailing.

(9) In Plain-Sailing, it is ſuppoſed the Earth and Sea makes one flat Superficies, or Long-ſquare; in which the Meridians are Parallel, and the Degrees of Latitude and Longitude equal in all Places; which is true only under the Equinoctial: In *Mercator's* Sailing, the Earth and Sea is ſuppoſed to make one round Body or Globe, and makes Uſe of Meridianal Parts. Sailing by the middle Latit. nearly agrees with *Mercator*'s Sailing: But Great-Circle-Sailing is the exacteſt, though it be moſt difficult, it muſt be of Advantage to keep near to Great-Circle-Sailing, which is agreeable with the Sphere in all Reſpects.

ASTRONOMY

According to the

Ptolemaick Syſtem.

ASTRONOMY. *Problem* I.

(*Ptolemaic Syſtem.*)

To rectify the Aſſimilo.

TO rectify the *Aſſimilo* to any Latitude given; move the reſpective Pole, (*viz.* the North-Pole, if the Latitude given be Northern; the South-Pole, if Southern) above the Horizon, till there are ſo many Degrees of the Meridian between the ſaid Pole and the Horizon, as anſwer to the Latitude given. Thus the North Pole being elevated 51 Degrees, and a half, the *Aſſimilo* is rectified for the Latitude of *London*.

ASTRONOMY. *Problem* II.

(*Ptolemaic Syſtem.*)

To find the Sun's Place in the Eclip-tick.

THE Day of the Month given; to find the Sun's Place in the Ecliptick; ſeek the Day of the Month (in either of the *Julian* or *Gregorian* Account) place in the Kalendar,

dar, on the upper ſide of the Horizon, righ againſt it; and in the innermoſt Circle, is th Sign, and Degree, the Sun ſhall be in tha Day at Noon (1).

Example, the 10th of *May* in the *Julian*, or 20th of the *Gregorian* Account; find th Sun's Place in the Ecliptick? Right againſt the 10th of *May* in the *Julian*, and 20th in the *Gregorian*, is the firſt of *Gemini*: Or if we count the Number of Days from *March* the 10th, to the 10th of *May*, given in the Queſtion, makes 60 Days, and count 60 Degrees from the Beginning of *Aries*, is the firſt of *Gemini*. The

To find the the Sun's Declination and right Aſcenſion.

ASTRONOMY. *Problem* III and IV.

(*Ptolemaic Syſtem.*)

IN the Latitude of *London*. The 10th day of *May*, Old Style, find the Sun's Delcination, and right Aſcenſion (2).

Of the Kalendar in the Aſſimilo.

Of the annual Motion.

(1) In the former Partitions it appears that either the Sun or Earth moves 360 Degrees in 365 Days; therefore tha Motion is near 1 Degree every Day, or 24 Hours: and as the Kalendar is divided into 12 equal Parts or Signs, to eac of thoſe belongeth 30 Days, 10 Hours; therefore in the Kalendar I have put a Day to each Degree, and at the end of every two Signs omitted one Day, which accounts for th odd Hours. The Aſtronomers all agree that the Sun is upon the Equinoctial *March* the 10th Day, or 9th; therefore in a Quarter of a Year, *viz.* 91 Days, 6 Hours more, *viz.* *June* the 10th, he muſt be at the Tropick of *Cancer*, and in 91 Days, 6 Hours more, *viz.* *September* the 10th, or 12th, upon the Equinoctial again; and in 91 Days, 6 Hours more, *viz.* *December* the 10th, at the Tropick of *Capricorn*, and in 91 Days, 6 Hours more, *March* the 10th, or 9th, a the ſame Point of the Ecliptick again, ſo finiſhed the Year.

(2) In Fig. 1. with 60 from Chords, or 90 from Sines, deſcribe the Primitive Circle W N E S, and draw the Eclip-

tick

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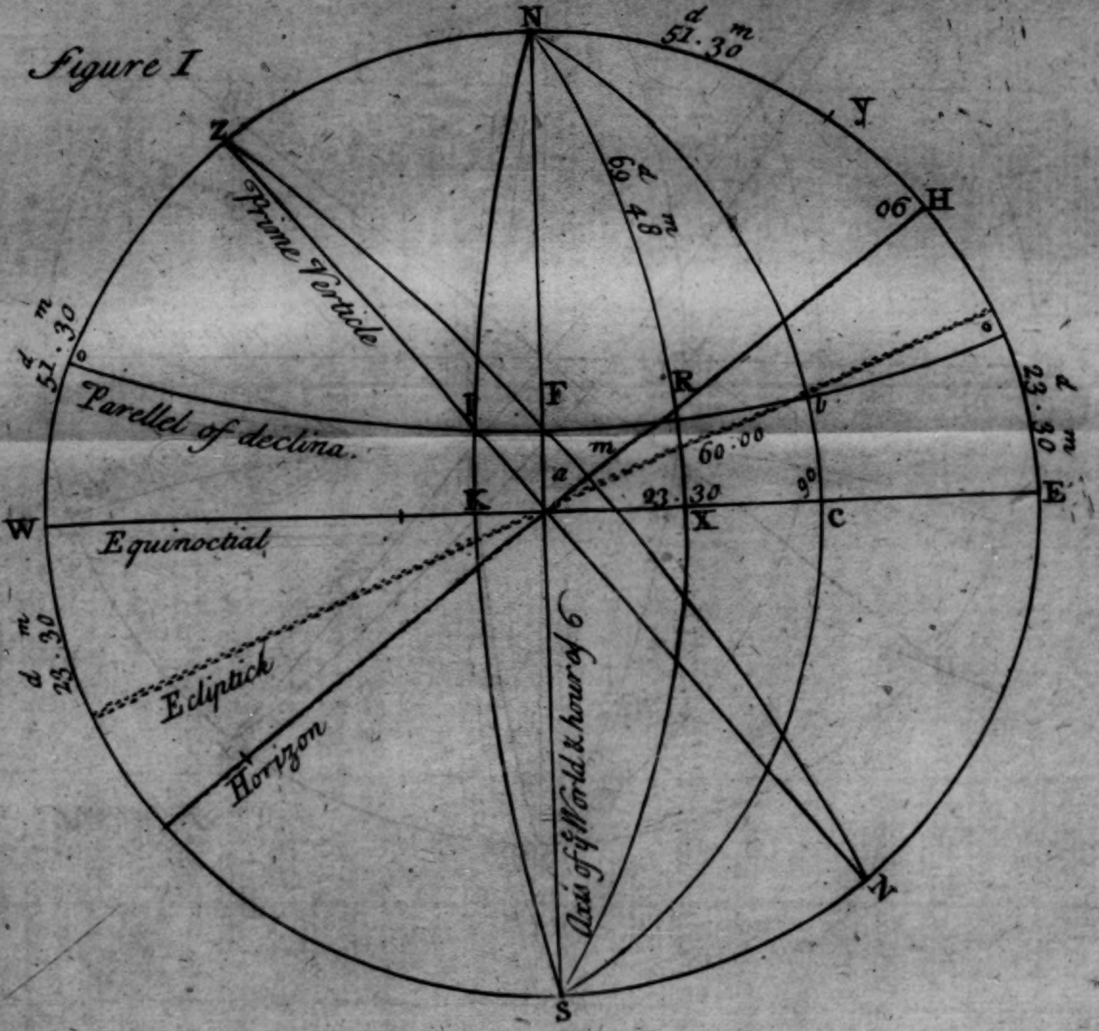
Figure I



The PROPORTIONS.

As Radius			10.000000
		d. m.	
To Sine	AB	60.00	9.937531
To Sine	BAC	23.30	9.600700
To Sine	BC	20.12	9.538231

The Declination North.

As Radius		10.000000
	d. m.	
The Sine Com. CAC	23.30	9.962398
So Tangent AC	60.00	10.238561
To Tang. AC	57.48	10.200951

The Right Aſcenſion.

Aſtronomy by the Aſſimilo.

By the Aſſimilo. Put the Sun to the firſt Degree of *Gemini*, his Place (as by *Problem* II.) and bring it to the Meridian; on which, and right over the Sun is 20 d. 12 m. North, his Declination required; and then look what Degree of the Equinoctial is cut by the Meridian, and it is 57 d. 48. m. the Right Aſcenſion counted from *Aries*.

Aſtronomy the Geometrical Projection.

tick at 23 d. 30 m. Diſtance from the Equinoctial, from N lay 51 d. 30 m. to H, and draw the Horizon, and at Right Angles to it draw the prime Verticle, then is the Figure or Sphere projected, according to the Latitude of *London*. Then lay 60 d. 00 m. the Sun's Longitude, or his Diſtance from *Aries* in the Ecliptick, found by *Prob.* 2. from A to B, (and by Spherical Geometry) draw the Great Circle NCS, which will cut the Equinoctial at C. Then the Side BC reduced to the primitive Circle is meaſured on Chords from E to O, and is 20 d. 12 m. the Sun's Declination North, and the Side AC meaſured on half Tangents is 57 d. 48 m. the Sun's Right Aſcenſion, counted from the beginning of *Aries* according to the Order or Succeſſion of the Signs.

ASTRONOMY. *Problem* V *and* VI. (*Ptolemaick Syſtem.*

To find the Sun's Amplitude and Aſcenſional Difference.

IN the Latitude of *London*, the 10th Day of *May*, Old Style; find the Sun's Amplitude and Aſcenſional Difference (3.)

The PROPORTIONS.

		d. m.	
As Sine Comp.	HN	51.30	9.794150
To Radius			10.000000
So Sine Comp.	RN	69.48	9.538194
To Sine Comp.	RH	33.40	9.744044
Therefore RA is Ampl.		33 40	
As Radius			10.000000
To Tang.	HN	51.30	10.099395
So Tang. Comp.	RN	69.48	9.565763
To Sine Comp.	RNH	27.30.	9.665158
And RNA Aſcen. Differ.		27.30	

Aſtronomy by the Aſſimilo.

By the *Aſſimilo*, which being rectified according to the given Latitude, and given Time; as in the former Problems; and the Sun being put to his proper Place, as therein directed; bring it down to the Horizon

Aſtronomy The Geometrical Projection.

(3) In Fig. 1 on the primitive Circle (now the Meridian of the Place lay 51 d. 30 m. from Chords) the Latitude of the Place or height of the Pole, from N to H, then by Spherical Geometry draw O O Parallel to the Equinoctial at 20 d. 12 m (the Declination found in *Prob.* 3) from it, to cut the Horizon in R, the Place of the Sun's Riſing and Setting, through NRS draw an oblique Circle, then is NR the Comp. of the Declination, *viz.* 69 d. 48 m. and A R being the Comp. of RH, meaſure A R on half Tangents and it is 33 d. 40 m. the Amplitude required; and RNA being the Comp. of RNH, meaſure RNA from A to X on half Tangents its 27 d. 30 m. the aſcenſional Difference.

on the Eaſt ſide thereof, and count on the Horizon from the Eaſt to the Sun, and it is 33 d. 40 m. Northwards, the Suns Amplitude at his Riſing, and bring the Sun even with the Weſt-ſide of the Horizon; and between the Weſt and the Sun, is 33 d. 40 m. his Amplitude at ſetting; for the Amplitude is the ſame both at riſing and ſetting. *Note*, the Sun is brought to any Place required, by keeping him fixed at his proper Place, according to given Time, and by turning round the Armillary Sphere in the *Aſſimilo*.

Aſcenſional Difference, is the Difference between the Right and Oblique Aſcenſion, or Deſcenſion; or it is the Space of Time the Sun Riſeth or Setteth before, or after 6 o' Clock, and its Uſe will appear in the two following Problems. By

ASTRONOMY. *Problem* VII and VIII.

(*Ptolemaic Syſtem.*)

To find the oblique Aſcenſion and Deſcenſion, the Sun's Riſing and Setting.

IN the Latitude of *London* the 10th Day of *May*, Old Style, find the oblique Aſcenſion and Deſcenſion, the Sun's Riſing and Setting, and the length of Day and Night. (4)

Of the Sun's Motion.

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(4) In reducing Degrees and Miles into Hours and Minutes, divide them by 15, becauſe the Sun appears to move 15 Degrees every Hour; the Aſcenſional Difference in this Queſtion is 27 d. 30 m. equal to 01 h. 50 m.

```
         h. m.
15) 27.30. (1 50.
    15
    --
    12
    60
    ---
    750
    75
    ---
     00
```

By

And length of Day and Night.

	d.	m.
By *Prob.* 4. The right Aſcen. is found to be	57.	48
By *Prob.* 6. The Aſcen. Diff. found to be	27.	30
The Sum is the Deſcenſion	85.	18
The Difference is the Aſcenſion	30.	18
By *Prob.* 6. The Aſcen. Diff. is found to be	27.	30
	h.	m.
Being reduced into Time, is	01.	50
	06.	00
Added to 6 o' Clock is Sun-ſetting	07.	50
Subſtracted from 6 is Sun-Riſing	04.	10
The Time of Sun-ſetting doubled is the Length of the Day	15.	40
The Time of Sun-Riſing doubled is the Length of the Night	08.	20

Aſtronomy by the Aſſimilo. By the *Aſſimilo.* Put the Sun to his proper Place as found in the former Problems, and bring it to the Meridian, and ſet the Hour Index to the upper 12 in the Hour Circle; then let the Index turn round with the Armillary Sphere, till the Sun be upon the Eaſt-ſide of the Horizon, then will the Hour Index point 4 Hours, 10 Minutes, the Time of Sun-Riſing; and then ſee what Degree of the Equinoctial is cut by the Horizon, and it is 30 d. 18 m. the Sun's oblique Aſcenſion: Then turn round till the Sun be upon the Weſt-ſide of the Horizon, and nd the Index will point to 7 Hours, 50 Min. he Time of Setting, and the Degree of the quinoctial cut by the Horizon is 35d. 18m. he Sun's oblique Deſcenſion.

ASTRONOMY. *Problem* IX and X.
(*Ptolemaic Syſtem.*)

To find the Sun's Altitude and Azimuth at Six o' Clock.

IN the Latitude of *London* the 10th Day of *May*, Old Style; find the Sun's Altitude and Azimuth at the Hour of Six (5.)

The PROPORTIONS.

As Radius		10.000000
	d. m.	
To Sine HAN	51.30	9.893544
So Sine AS	20.12	9.538194
To Sine SM	15.40	9.431738
The Altitude is	15.40	at 6 o'Clock.
As Radius		10.000000
To Sine Comp. HAN	51.30	9.794150
So Tang. AF	20.12	9.565763
To Tang. AM	12.55	9.359913
The Azimuth is	12.55	at 6 o' Clock.

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(5) In Fig. 1. By Spherical Geometry, through f, where the Parallel of Declination cutteth the Axis, draw the oblique Circle ZFN to cut the Horizon in M, then HAN is equal to the Latitude given 51 d. 30 m. and a f 20 d. 12m. is the Declination found in Prob. 3. Then f m is meaſured on Chords when reduced to the primitive Circle from H to Y and is 15 d. 40 m. the Altitude at 6 o' clock and am on half Tangents and is 12 d. 55 m. the Suns Azimuth from the Eaſt.

Aſtronomy by the Aſſimilo.

By the Aſſimilo, the Machine and Hour Index being rectified, as before directed, ſcrew the Quadrant of Altitude in the Zenith, which is called rectifying the Quadrant of Altitude to the Latitude of the Place given, (and in this Queſtion is *London*;) turn the armillary Sphere till the Index point to the given Hour, (and in this Queſtion is Six o' Clock;) move the Quadrant of Altitude till the graduated edge of it lie juſt over the Sun, and look what Degree, on the Quadrant of Altitude, is againſt the Sun, and it is 15 d. 40 m. the Sun's Altitude; and look what Degree of the Horizon is cut by the graduated edge of the Quadrant of Altitude, counted from the North, or South, and it is the Sun's Azimuth; or it may be counted from the Eaſt or Weſt, or from the neareſt of them; and in this Queſtion counted from the Eaſt, and is 12 d. 55 m. the Azimuth; or 77 d. 05 m. from the North, at Six o' Clock in the Morning, and 12 d. 55m. from the Weſt or 77 d. 05 m. from the North at Six o' Clock in the Afternoon.

To find the Sun's Altitude and Hour when he is Eaſt or Weſt, *viz.* the Hour of the Day

ASTRONOMY. *Problem* XI and XII.

(*Ptolemaic Syſtem.*)

IN the Latitude of *London*, the 10th Day of *May*, Old Style; find the Sun's Altitude and the Hour of the Day when he is Eaſt or Weſt (6) *The*

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(6) In Fig. 1. By Spherical Geometry, through I, where the Parallel of Declination cutteth the prime Verticle, (the Place

The PROPORTIONS.

	d. m.	
As Sine WAZ	51.30	9.893544
To Radius		10.000000
So Sine IK	20.12	9.538194
To Sine IA	26.10	9.644650

The Altitude is 26.10 when the Sun is Eaſt or Weſt.

As Radius		10.000000
To Tang. Comp. WAZ	51.30	9.900605
So Tangent IK	20.12	9.565763
To Sine AK	17.00	9.466368

And the Hour of the Day is 17d. 00 m. when the Sun is Eaſt or Weſt, and the ſaid 17d. 00 m. reduced into Time is 01*h*. 08*m*.
06*h*. 00*m*.

Place of the Sun when Eaſt or Weſt) draw the oblique Circle NIS to cut the Equinoctial in K, then WAZ is equal to the Latitude given 51 d. 30 m. and IK is the Declination found in *Prob.* III. *viz.* 20 d. 12 m. Then IA meaſured on half Tangents is the Altitude, and is 26 d. 10 m. and AK meaſured on half Tangents is the Hour of the Day when the Sun is Eaſt or Weſt, and is 17 d. 00m reduced into Time (as ſhewn in *Prob.* VIII.) is 1 Hour and 8 Minutes; which added to, or ſubſtracted from ſix Hours, gives the Hour of the Day required.

	d. m.
And added to 6 o' Clock ſheweth the Sun is Eaſt at Morning.	07.08
Subſtracted from 6, ſheweth the Sun is Weſt at Evening.	04.52

Aſtronomy by the *Aſſimilo*.

By the *Aſſimilo*, the Machine, Index, and Quadrant of Altitude, being all rectified as before, put the Quadrant of Altitude to the Eaſt Point upon the Horizon, bring the Sun to the ſaid Quadrant, which ſheweth the Sun's Altitude is 26 d. 10 m. and the Index points to 7 Hours, 8 Minutes, the time of the Day in the Morning, and then move the Quadrant of Altitude to the Weſt Point of the Horizon, and bring the Sun to the ſaid Quadrant, which ſheweth the Sun's Altitude is 26 d. 10 m. the ſame as before, and the Index points to 4 Hours, 52 Minutes, the Time of the Day in the Afternoon.

In *Prob.* IX and X. the Sun's Altitude is 15 d. 40 m. and his Azimuth 12 d. 55 m. put the Sun to 15 d. 40 m. on the Quadrant of Altitude, the Index will point to 6 o' Clock, the Hour of the Day; or put the Quadrant of Altitude to 12 d. 55 m. the Azimuth from Eaſt towards North, bring the Sun to the ſaid Quadrant, and the Index points to 6 o' Clock the Hour, of the Day, the ſame as before; and ſo the Hour of the Day may be found at any time.

ASTRO-

ASTRONOMY

According to the

(*Copernican Syſtem.*)

ASTRONOMY. *Problem* I.

(*Copernican Syſtem.*)

To rectify the *Aſſimilo.*

TO rectify the *Aſſimilo* to any Latitude given, move the reſpective Pole, (*viz.* the North Pole, if the Latitude given be Northern; the South Pole, if the Latitude be Southern) above the Horizon, till there are ſo many Degrees of the Meridian between the ſaid Pole and the Horizon, as anſwer to the Latitude given: Thus the North Pole being elevated 51 Degrees and an half, the Machine is rectified for the Latitude of *London*.

ASTRONOMY. *Problem* II.

(*Copernican Syſtem.*)

To find the Earth's Place in the Ecliptick.

THE Day of the Month given to find the Earths Place in the Ecliptick; ſeek the Day of the Month, (in either the *Julian* or *Gregorian* Account) placed in the Kalendar on the upper ſide of the Horizon; right againſt it, and in the innermoſt Circle is the Sig and Degree the Sun appears to be in th Day at Noon.

Example. The 10th Day of *May*, in th *Julian*, or 20th, of the *Gregorian* Account find the Sun's Place in the Ecliptick, whic is the firſt Degree of *Gemini*; or if w count the Number of Days from *Marc* the 19th, to the 10th of *May* given in the Queſtion, makes 60 Days, and count 6 Degrees from the beginning of *Aries*, is th firſt of *Gemini*, and the oppoſite Point is th firſt Degree of *Sagittarius*, which is th Earth's Place in the Ecliptick required. (1)

ASTRONOMY. *Problem* III and IV.

(Copernican Syſtem.)

To find the Sun's Declination and Right Aſcenſion.

IN the Latitude of *London*, the 10th Day of *May*, Old Style, find the Sun's Declination and Right Aſcenſion. (2)

The

Of the Earths Place in the Ecliptick.

(1) According to this Syſtem, the Earth, in its real motion, is always in the point of the Ecliptick, oppoſite to that wherein the Sun appears to be, as explain'd in *Partition* III.

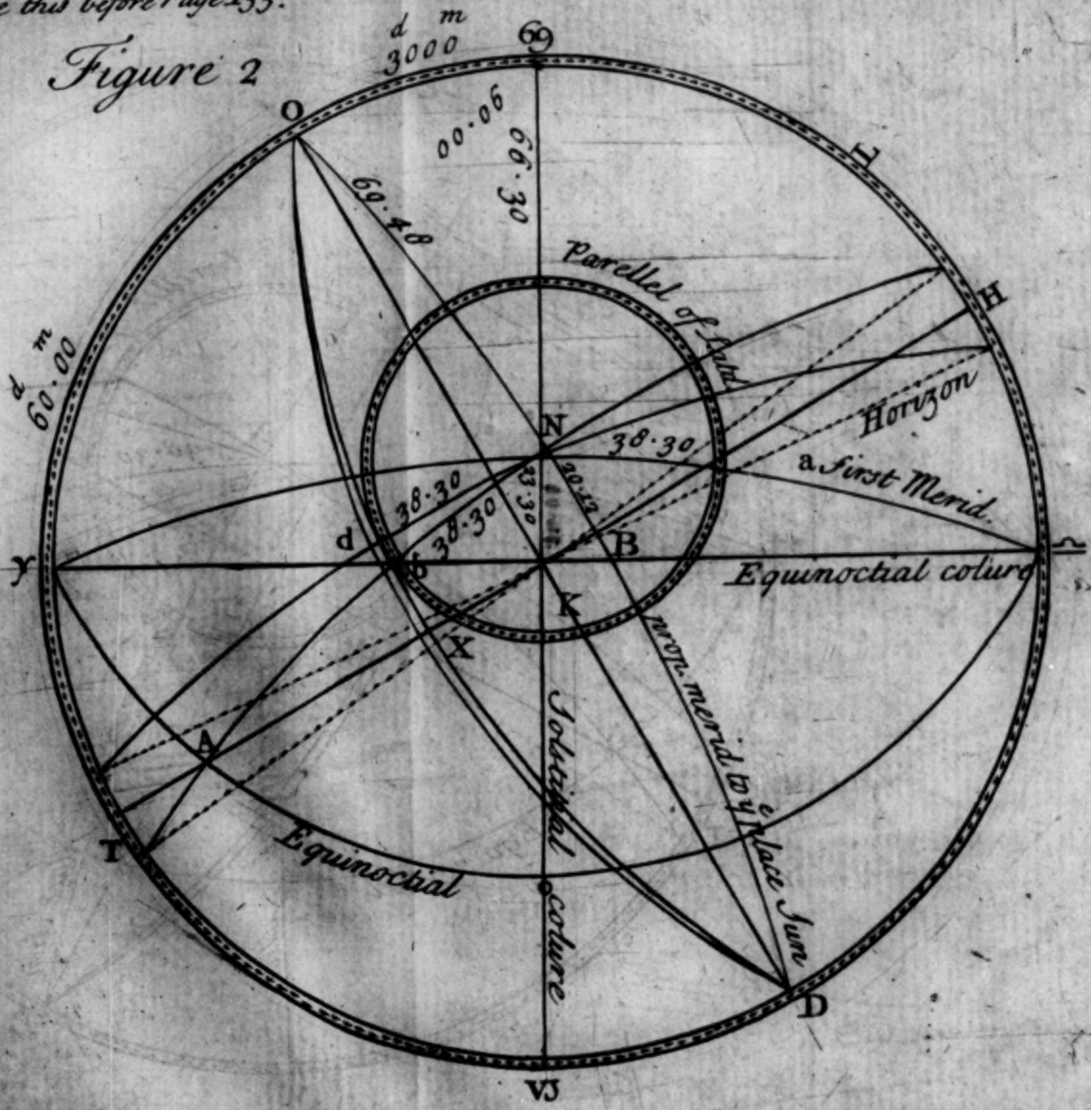
Aſtronomy the Geometrical Projection.

(2) In Fig. [illegible]. with 60 from Chords, or 90 from Sines, deſcribe the primitive Circle ♈ ♋ ♎ ♑ now the Ecliptick: from K. its pole lay 23 d. 30 m. from half Tangents to N. (for that is the diſtance between the North Pole and Pole of the Ecliptick) from Chords take 60 d. 00 m. the Sun's Longitude (*viz.* his Diſtance in the Ecliptick as found in *Prob.* II.) lay it from ♈ to ☉, and draw ☉KD, and at right Angles to draw the Horizon, and by Spherical Geometry, draw the Equinoctial, and the Circle ☉ND, the proper Meridian, to the Place of the Sun, and ♈N♎ called the firſt Meridian, and the Latitude of *London* being 51 d. 30 m. its Comp. is 38 d. 30 m. and the two Poles Diſtance is 23 d. 30 m. added to 38 d. 30 m. is 62 d. 00 m. which ſet from K towards 60 from half Tangents, and 23 d. 30 m. ſubſtracted from 38 d.

20 m.

Place this before Page 133.

Figure 2



The PROPORTIONS.

As Radius			10.000000
		d. m.	
To Sine Comp.	☉ ♋,	30.00	9.937531
So Sine Comp.	♋ N,	66.30	9.600700
To Sine Comp.	N ☉	20.12	9.538231

Which is NB the Reflection, and is equal to the Sun's Declination in the *Ptolemaic Syſtem.*

As Radius			10.000000
To Sine	♋ N	66.30	9.962398
So Tang. Comp.	♋ ☉	30.30	10.238561
To Tang. Comp.	♋ N ☉	57.48	10.200959

And 57 d. 48 m. is the Sun's right Aſcenſion from the neareſt Equinox.

Aſtronomy by the *Aſſimilo.*

By the *Aſſimilo*, put the Earth to the firſt Degree of *Sagittarius*, its proper Place is found in *Problem* II. and bring it to the Meridian, on which and right over the Earth is 20 d. 12 m. South, the Sun being

always

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o m. the Remainder is 15 d. 00 m. which ſet from K to
ards ♑, the middle between theſe Marks is the Center of
e Circle, which is the Parallel of Latitude, and is called
e Path of the *Vertex*, then is the Fig. or Sphere projected
ccording to the Latitude of *London*; then ♋ ☉ 30 d. 00m.
the Comp. of 60d. 00m. the Sun's Longitude, and ♋
. 66d. 30 m. the Comp. of 23 d. 30 m. the diſtance of the
vo Poles; and if NB (being reduced to the primitive Circle,
meaſured from H to L, is 20 d. 12 m. the Declination
quired, and ♋ N ☉ ſo reduced and meaſured from ♑
T is 57 d. 48 m. the Right Aſcenſion required.

always oppoſite to the Earth, he then muſt be 20 d. 12 m. North, his Declenſion required, and then look what Degree of the Equinoctial is cut by the Meridian, and it is 237d. 48 m. and as the Sun is oppoſite, they muſt be 180 d. 00 m. aſunder; therefore ſubſtract 180 d. 00 m. from 237 d. 48 m, the Remainder is 57 d. 48 m. the Sun's right Aſcenſion required.

ASTRONOMY. *Problem* V *and* VI. (*Copernican Syſtem.*)

To find the Sun's Amplitude and Aſcenſional Difference.

IN the Latitude of *London*, the 10th Day of *May*, Old Style, find the Sun's Amplitude and Aſcenſional Difference. (3)

The PROPORTIONS.

		d. m.	
As Sine	NA	38.30	9.794150
To Radius			10.000000
So Sine	NB	20.12	9.538194
To Sine	BAN	33.40	9.744044

Aſtronomy the Geometrical Projection.

(3) In Fig. 2. the Side NA 30d. 33m. is the Comp. of the Latitude, or the Diſtance of the Pole from the *Vertex*, and NB 20d. 12m. is the Declination found in *Prob.* III. Then the Angles BAN and BNA (when reduced to the primitive Circle, by Spherical Geometry) the former is 33 d. 40 m. the Amplitude meaſured by the Scale on Chords; the Latter is 27 d. 30 m. the Aſcenſional Difference; and likewiſe muſt be meaſured by the Scale on Chords, as has been ſhewn in in the former *Problems.*

The Amplitude is 33d. 40. m from the Eaſt Northerly at Riſing, and from the Weſt Northerly at Setting is the like, 33 d. 40 m.

		d m.	
As Radius			10.000000
To Tang. Comp.	NA	38.30	10.099395
So Tang.	NB	20.12	9.565763
To Sine Comp.	BNA	27.30	9.665158

The aſcenſional Difference is 27 d. 30 m. which is equal in Time to 1 h. 50 m. before Six, his Riſing; and as much after Six, his Setting; becauſe its North Latitude, and the Sun in a North Sign; but contrary when one is North and the other South.

Aſtronomy by the *Aſſimilo.*

By the *Aſſimilo*, which being rectified according to the given Latitude, and given Time, as in the former *Problems*, and the Earth being put to its proper Place, as therein directed, bring it down to the Horizon on the Eaſt ſide thereof, and count on the Horizon from Eaſt to the Earth, and it is 33 d. 40 m. Southwards; and as the Sun is always oppoſite to the Earth, he muſt be 33 d. 40 m. Northwards, and bring the Earth even with the Weſt ſide of the Horizon, and between the Weſt and the Earth is 33d. 40 m. Southwards, therefore the Sun muſt be ſo much Northwards; ſo that the Sun's Amplitude is 33 d. 40 m. both at his Riſing and Setting. *Note*, The Earth is brought to any Place required, by keeping it fixed to its proper Place, and by turning round the Armillary Sphere.

The aſcenſional Difference is the Difference between the right and oblique Aſcenſion or Deſcenſion. Its Uſe will appear in the next *Problems.*

ASTRONOMY. *Problem* VII *and* VIII.
(*Copernican Syſtem.*)

To find the oblique Aſcenſion and Deſcenſion, The Sun's Riſing and Setting. Length of Day and Night

IN the Latitude of *London*, the 10th Day of *May*, Old Style; find the oblique Aſcenſion and Deſcenſion, the Sun's Riſing and Setting, and the length of Day and Night. (4)

	d. m.
By *Prob.* 4. The right Aſcen. is found to be	57.48
By *Prob.* 6. The Aſcen. Diff. found to be	27.30
The Sum is the Deſcenſion	85.18
The Difference is the Aſcenſion	30.18

Of the Earths Motion.

(4) When Degrees and Miles are reduced to Hours and Minutes, divide by 15, becauſe the Earth moves 15 Degrees every Hour, the Aſcenſional Difference in this Queſtion is 27d. 30 m. equal to 01 h. 50 m.

```
15) 27. 30 (1.50
    15
    ——
    12
    61
    ———
    750
     75
    ———
    (00)
```

By

	m. d.
By *Prob.* 6. The Aſcen. Diff. is found to be	27.30
	m. h.
Reduced into Time is	01.50
	06.00
Added to 6 o'Clock is Sun Setting	07.50
Subſtracted from 6 o'Clock is Sun Riſing	04.10
The Time of Sun Setting doubled is the Length of the Day ——	15.40
The Time of Sun Riſing doubled is the Length of the Night	08.20

Aſtronomy by the *Aſſimilo*.

By the *Aſſimilo* put the Earth to its proper Place, as found in the former *Problems*, and bring it to the Meridian, and ſet the Hour Index to the upper 12, in the Hour Circle, then let the Index turn round with the Armillary Sphere, till the Earth be upon the Eaſt ſide of the Horizon, then will the Hour Index point to 7 Hours 50 Minutes, the Time of Sun-ſetting (for when the Earth ſets upon the Horizon in the Eaſt, the Sun appears to us to ſet in the Weſt, at the ſame time) and then ſee what Degree of the Equinoctial is cut by the Horizon, and it is 265 d. 18 m. and as the Sun is oppoſite they muſt be 180 d. 00 m. aſunder, therefore ſubſtract 180 d. 00 m. from 265 d. 18 m. the Remainder 85 d. 18 m. is the Sun's Aſcenſion; then turn round till the Earth be upon the Weſt ſide of the Horizon, and the Index will point to 4 Hours 10 Minutes, the Time of Sun-riſing (for when the Earth riſes upon the Horizon in the Weſt, the Sun appears to us to riſe in the Eaſt, at the ſame time) and then is 210 d. 18 m. cut by the Horizon, from which ſubſtract 180 d. 00 m. and the Remainder 30 d. 18 m. is the Sun's Aſcenſion.

ASTRONOMY. *Problem* IX *and* X.

(*Copernican Syſtem.*)

To find the Sun's Altitude and Azimuth at Six o' Clock.

IN the Latitude of *London*, the 10th Day of *May*, Old Style, find the Sun's Altitude and Azimuth at the Hour of Six. (5)

The PROPORTIONS.

As Radius			10.000000
		d. m.	
To Sine Comp.	NC	38.30	9.893544
So Sine Comp.	N☉	69.48	9.538194

Aſtronomy the Geometrical Projection.

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(5) In Fig. 2 thro' N, and A, the Point where the Horizon interſects the Equinoctial, draw a great Circle to cut the Parallel of Latitude in C; then thro' ☉ and C draw a great Circle ☉CD (both by ſpherical Geometry;) and then the Side N C, 38d. 30m. is the Complement of the Latitude, N☉ 69 d. 48m. is the Complement of the Declination found by *Prob.* III. and the Complement of the Side C☉ Cx, reduced to the primitive Circle, is meaſured by the Scale on Chords, and is 15 d. 40 m. the Sun's Altitude at the hour of ſix, and the Angle N C ☉, being alſo reduced, is meaſured by the Scale on Chords, and is 12 d. 55 m. the Sun's Azimuth, from Eaſt or Weſt.

		d. m.	
To Sine Comp.	C☉	15.40	9.431738
The Sun's Altitude is		15.40	at the hour 6.
As Radius			10.000000
To Sine	NC	38.30	9.794150
So Tangent	N☉	69.48	9.565763
To Tang. Com.	NC☉	12.55	9.359913

The Azimuth is 12.55. from the Eaſt at 6 in the Morning, but from Weſt at 6 in the Afternoon.

Aſtronomy by the *Aſſimilo*.

By the *Aſſimilo*, the Machine and Hour Index being rectified (as before directed) inſtead of the Quadrant of Altitude ſcrew the Semi-Circle, called the Circle of Poſition, in the Zenith; then turn the Armillary Sphere till the Index point to the given Hour; which in this Queſtion is 6 o' Clock, and move the Semi-Circle till it lye juſt over the Earth; look what Degree of the Semi-Circle is againſt the Earth, and it is 15 d. 40 m. the Earth's Depreſſion; and as the Sun is always oppoſite to the Earth, he muſt appear to be elevated 15 d. 40 m. the Sun's Altitude required. And look what Degree of the Horizon is cut by the Semi-Circle, and it is 12 d. 55 m. from the Weſt, or 77 d. 05 m. from the South, the Sun being oppoſite, his Azimuth muſt be 12 d. 55m. from the Eaſt, or 77 d. 05 m. from the North, at 6 Clock in the Morning; and 12 d. 55 m. from the Weſt, or 77 d. 00 m. from the North, at 6 o' Clock in the Afternoon.

ASTRONOMY. *Prob.* XI *and* XII.

(*Copernican Syſtem.*)

To find the Sun's Altitude and Hour of the Day.

IN the Latitude of *London*, the 10th Day of *May*, Old Style, find the Sun's Altitude, and Hour of the Day when he is Eaſt or Weſt. (6)

The PROPORTIONS.

		d. m.	
As Sine Comp.	N d	38.30	9.893544
To Radius			10.000000
So Sine Comp.	⊙N	69.48	9.538194
To Sine Comp.	⊙d	26.10	9.644650

The Sun's Altitude is 26.10 when he appears to be Eaſt or Weſt.

As Radius			10.000000
To Tang.	Nd	38.30	9.900605
So Tang. Comp.	ON	69.48	9.565763
To Sine Comp.	OND	17.00	9.466368

Aſtronomy the Geometrical Projection.

(6) In Fig. 2. through ⊙ D draw a great Circle juſt to touch the Path of the Vertex, at d, and thorough N and d draw a great Circle to cut ⊙ d D at right Angles, (both by Spherical Geometry) and then the Side Nd, 38 d. 30 m. is the Comp. Latitude, and ⊙N 69d. 48m. Comp. Declination found by *Prob.* III. and the Complement of the Side ⊙A is d x, reduced to the primitive Circle, is meaſured by the Scale on Chords, and is 26 d. 10 m. the Sun's Altitude, when he appears Eaſt or Weſt; the Angle ⊙N d being alſo reduced to the primitive Circle, and meaſured by the Scale on Chords, is 17d. 00m. and is equal to one Hour eight Minutes, which added to or ſubſtracted from ſix o' clock, ſheweth the hour of the Day when the Sun is Eaſt or Weſt.

d. m.
The Hour of the Day is 17 00 when the Sun appears to be Eaſt or Weſt, and 17 00 reduced to Time is —— 01 *h.* 08 *m.*
06 *h.* 00 *m.*

Added to 6 o' Clock, ſheweth the Sun is Eaſt at Morning ——	07.08
Subſtracted from 6, ſheweth the Sun is Weſt at Evening ——	04.52

Aſtronomy by the *Aſſimilo.*

By the *Aſſimilo*, the Machine Index and Semi-Circle being all rectified as before, put the Semi-Circle to the Weſt Point upon the Horizon, bring the Earth to the ſaid Semi-Circle, which ſheweth the Earth's Depreſſion is 26 d. 10 m. and as the Sun is always oppoſite to the Earth, he muſt appear to be elevated 26 d. 10 m. the Sun's Atitude required, and the Index points to 7 Hours 8 Minutes, the Time of the Day in the Morning; then move the Semi-Circle to the Eaſt Point of the Horizon, and bring the Earth to the ſaid Semi-Circle, which ſheweth the Earth's Depreſſion is 26 d. 10 m. equal to the Sun's Altitude as before, and the Index points to 4 Hours, 52 Minutes the Time of the Day in the Afternoon.

In *Prob.* IX. and X. The Sun's Altitude is 15 d. 40 m. his Azimuth is 12 d. 55 m. from

Eaſt Northward (as the Earths Depreſſion is always equal to the Sun's Elevation) put the Earth to 15 d. 40 m. on the Semi-Circle, and the Index points to 6 o' Clock, the Time of the Day; or put the Semi-Circle to 12 d. 55 m. from the Eaſt Southward, bring the Earth to the ſaid Semi-Circle, the Index points to 6 o' Clock, the Time of the Day, the ſame as before.

And ſo the Hour of the Day may be found at any Time.

Aſtronomy according to both Syſtems.

I have ſolved the more uſeful *Problems* of Aſtronomy, and ſhewn the Proportions, Projections, and the Demonſtrations, by the *Aſſimilo*, according to both the *Ptolemaic*, and the *Copernican Syſtems*; and find they exactly agree, as appears by the ſeveral Examples. I will next, ſhew how to find the Variation of the *Magnetical Compaſs*, and the Latitude by Obſervation; and demonſtrate them by the *Aſſimilo*, and then conclude.

Of the Variation of the Compaſs.

The Variation of the Compaſs, what it is, how to find it, and how to rectify the Mariner's Compaſs thereby.

Variation of the Compaſs is an Arch of the Horizon contained between the Meridian of the Place, and the magnetical Meridian; it is either Eaſt or Weſt, and never exceeds 90 Degrees.

Eaſt Variation, is when the North-part of the Magnetical Meridian lieth to the Eaſtward of the North part of the Meridian of the Place; cut it to the Weſtward, then it is called Weſt-Variation.

Magnetical Meridian, is a great Circle paſſing through the Magnetical Poles, (near the Poles of the World) to which Meridian the Compaſs (if not otherwiſe hinder'd) hath Reſpect.

Magnetical Amplitude, is an Arch of the Horizon, contained between the Sun (at his Riſing or ſetting) and the Eaſt, or Weſt-points of the Compaſs; or it is the apparent Riſing or Setting of the Sun, from the Eaſt or Weſt points of the Compaſs; and is found by obſerving the Sun, either at his Riſing or Setting, by an Amplitude-Compaſs.

True Amplitude in an Arch of the Horizon, contained between the Sun and either the Eaſt or Weſt point of the Horizon; and is found by *Problem* V. of Aſtronomy.

If the two aforeſaid Amplitude agrees; that is, the magnetical and true Amplitude, (which is ſeldom) there is no Variation; but if they differ, their Difference rightly counted, is the Variation.

The Amplitudes both North or both South; their Difference is the Variation: but one North, the other South, their Sum is it.

The Amplitudes (before your face) from you, if the true Amplitude be to the right hand of the Magnetical, the Variation is

Eaſt; but if to the left hand, then the Variation is Weſt.

EXAMPLE I.

To find the Variation of the Compaſs.

IN the Latitude of *London*, the 10th of *May*, Old Style, 1734. according to the Mariner's Compaſs, the Sun appears to riſe 17 d. 40 m. from the Eaſt towards the North; find the Variation.

	d. m.
By *Prob.* V. The true Amplitude is found to be from E. to W. and N.	33.40
By the Compaſs, the apparent Amplitude is from E. to W. and N.	17.40
Their Difference is the Variation, *viz.* Weſterly	16.00

To find the Variation by the *Aſſimilo*.

By the *Aſſimilo.* (1) The Machine being prepared and rectified, as formerly directed, according to the given Latitude and Time, ſcrew either the Quadrant of Altitude, or the Semi-Circle in the Zenith, and move it till the graduated Edge of it be againſt 33 d. 40. m. the true Amplitude; and bring the Sun (being in his proper Place) to it, for that is the Place of his Riſing: Then cauſe the

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(1) The Center of that Compaſs which repreſents the Mariner's Compaſs, is always ſcrewed to the Zenith; but is ſo contrived, as that it may be turned round as required, and ſhews the Variation of the Compaſs.

North Point of the Mariner's Compaſs, to point to the North-Pole; that is, lay it even with the graduated Edge of the large Meridian; then the graduated Edge of the Quadrant of Altitude, ſheweth the true Amplitude; and turn the Mariner's Compaſs till 17 d. 40 m. the apparent Amplitude, be even with the graduated Edge of the Quadrant of Altitude; then will the North Point of the Mariner's Compaſs be moved 16 d. 00 m, from the graduated Edge of the Meridian towards the Weſt: Therefore the Variation of the Mariner's Compaſs muſt be 16 d. 00 m. Weſterly.

EXAMPLE II.

To find the Variation of the Compaſs.

	d. m.
IN this Example the true Amplitude is found to be ———	18.00
From the Weſt, Northerly, and the Magnetical is ———	10.00

From the Weſt, Southerly, at Sun-Setting, find the Variation.

	d. m.
The true Amplitude is found to be from W. toward N.	18.00
The Magnetical Amplitude is from W. toward S.	10.00
Their Sum is the Variation, *viz.* Eaſterly. ———	28.00

To find the Variation by the *Aſſimilo.*

By the *Aſſimilo.* (2) The Machine being rectified as before, move the Quadrant of Altitude to 18 d. 00 m. from Weſt toward North, the true Amplitude, and bring the Sun thereto, for that is the Place of his Setting; then let the North Point of the Mariner's Compaſs point to the North Pole as before directed; then the Quadrant of Altitude ſheweth the true Amplitude 18 d. 00 m. and turn the Mariner's Compaſs till 10 d. 00 m. the magnetical, or apparent Amplitude, be even with the graduated Edge of the Quadrant of Altitude; then will the North Point of the Mariner's Compaſs be moved 28 d. 00 m. from the Meridian towards the Eaſt; therefore the Variation of the Mariner's Compaſs muſt be 28 d. 00 m. Eaſterly.

Of an Obſervation either of Sun or Star.

Of an Obſervation, either of Sun or Star, what it is; how, or with what, and when it it is taken, and finding the Latitude thereby.

An Obſervation is the finding either the Sun's or Stars Meridian Altitude, at Sea, with a Quadrant, or with a Croſs-Staff. Meridian Altitude,

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Of the Variation.

(2) The Variation may be found by an Azimuth as well as as by an Amplitude; but the Amplitude is generally uſed by Aſtronomers, when either the Azimuth, or Amplitude is known or found by *Prob.* V. and X. and Latitude of the Place, and the Sun's Declination, known or found by the former *Problems* of Aſtronomy; then by theſe Rules, the Variation of the Mariner's Compaſs may be found exactly, and the Compaſs accordingly rectified thereby.

Altitude, is the Height above the Horizon of the Sun, or Star, they being upon the Meridian of the Place of Obſervation, and that the Sun is every Day at Noon, but the Stars at different Times, according to the differing of their ſeveral right Aſcenſions from the Sun's right Aſcenſion.

The Meridian Altitude and Declination of one Kind; that is, both North, or both South; the Difference of the Zenith Diſtance, and the Declination is the Latitude required.

Note. When the Declination is greater than the Zenith Diſtance, the Latitude is of the ſame Name; but if leſs, contrary to the Declination.

The Meridian Altitude and Declination of contrary Names; that is, one North, the the other South: The Sum of the Zenith Diſtance, and the Declination is the Latitude required, of the ſame Name with the Declination.

By Meridian Altitude South, I mean, the Object obſerved is to the Southward of the Obſerver; and when North, then to the Northward.

By Zenith Diſtance, I mean, the Compliment of the Meridian Altitude of the Object obſerved.

The Elevation of the Pole is always equal to the Latitude of the Place; as demonſtrated in the former Partitions.

EXAMPLE I.

To find the Latitude by an Obſervation of the Sun.

ON the 10th of *May*, Old Style, 1734, the Sun's Meridian Altitude appears to be 82 d. 48 m. North; find the Latitude of the Place of Obſervation.

	d. m.
By *Prob.* III. The Sun's Declination is found to be	20.12. North.
The Complement of 28 d. 48 m. is the Zenith Diſtance	07.12. North.
Their Difference is the Latitude required ———	13.00. North.

And by theſe Rules the Latitude of any Place may be found, either by an Obſervation of the Sun, or an Obſervation of a Star.

To work an Obſervation by the *Aſſimilo.*

By the *Aſſimilo*, the Machine being prepared and rectified, and the Sun in his proper Place, as formerly directed; bring it to the Meridian, and the Sun being even with 20 d. 12 m his Declination North, then move the Meridian till 82 d. 48 m. the Meridian Altitude, be contained between the North Point of the Horizon and the Sun, and look how much the North Pole is elevated above the Horizon, and it is 13 d. 00 m. therefore the Latitude required muſt be 13 d. 00 m. North, and is the Latitude of *Barbadoes*; and ſo may the Latitude of any Place be found by the *Aſſimilo.*

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EXAMPLE II.

To find the Latitude by an Obſervation of the Sun.

On the 10th Day of *May*, Old Style, 1734. the Sun's Meridian Altitude appears to be 60 d. 12 m. South, find the Latitude of the Place of Obſervation.

	d. m.
By *Prob.* III. the Sun's Declination is found to be	20.12. North.
The Complement of 60 d. 12 m. is the Zenith Diſt.	29.48. South.
Their Sum is the Latitude required.	50.00. North.

To work an Obſervation by the *Aſſimilo*.

By the *Aſſimilo*, the Machine being prepared as before, bring the Sun to 20 d. 12 m. on the Meridian, the Sun's Declination; and move the ſaid Meridian till 60 d. 12 m. the Meridian Altitude, be contained between the South Point of the Horizon, and the Sun, and look how much the North-Pole is elevated above the Horizon and it is 50 d. 00 m. therefore the Latitude of the Place required muſt be 50 d. 00 m. North; and is the Latitude of the *Lizard* in *Great Britain*.

APPENDIX

Concerning the Copernican Syſtem OF THE PLANETS.

AS to this Part of the *Aſſimilo* it will be eaſily underſtood, being no other than a familiar Repreſentation of the Proportion of the Sun's and the Planets Bodies; as alſo of the mean Diſtances of thoſe Planets from the Sun. If the Sun therefore be ſuppoſed two Feet, or 24 Inches in Diameter, *Saturn's* Body will be about 2 Inches, his Ring 4$\frac{1}{2}$, *Jupiter* 2$\frac{1}{2}$, the Earth and *Venus* about $\frac{1}{4}$, *Mars* and *Mercury* about $\frac{1}{10}$, and the Moon's about $\frac{1}{20}$, of an Inch, Globes of which Diameter will therefore truly repreſent thoſe Planets. Now the Period of the

Concerning the *Copernican* Syſtem of the Planets.

the Earth and Moon about the Sun is one Year; the Period of *Saturn* and his 5 Moons, almoſt 30; of *Jupiter*, and his 4 Moons, almoſt 12; of *Mars*, almoſt 2; of *Venus*, about 8 Months; and of *Mercury* about 3 Months; as is the Period of the Moon about the Earth one Month.

The proportionable Diſtances of theſe Planets is here exhibited to the Eye, as in Fig. 1 and 2, next after the Index in this Book; and are alſo given in Mr. *Whiſton*'s Solar Syſtem, which is a full Explication of this Part of Aſtronomy.

In order therefore to give the Reader ſome diſtinct Notion of this Syſtem by the *Aſſimilo*, take the Armillary Sphere out of the Horizon, and put the ſtrong Style into the central Hole at the Bottom. On the Top of which Style place the ſeveral wooden Supporters of the ſeveral primary Planets, which hath the ſeveral Planets properly placed upon them, to move about the Center of the Horizon, which now repreſents the Plain of the Ecliptick; then place a gilded Ball on the Top of the Style, to repreſent the Sun, the inclining Plain repreſents the Orbit of the Moon, inclined to the Plain of the Ecliptick, about the Earth; and the Moon on the Top of a Wire on the ſhort Supporter, may be moved round the Earth in every Poſition of the Nodes of this Orbit, in order to repreſent the Eclipſes of the Sun and Moon, when the Nodes are in or near the Conjunction and Oppoſition; and the Reaſon why thoſe Eclipſes cannot happen in any other Poſition of the Nodes; for the Moon generally goes above or below the Sun's Disk, or the Earth's Shadow, and ſo but ſeldom affords any Eclipſe either of the Sun or Moon.

Of the Motion of Comets.

And if the Sun be put on the Earth's Place, and the Earth and Moon along with it be put on the Sun's Place, then the Machine will repreſent the *Ptolemaic Syſtem.* When you have a Mind to repreſent the Motion of Comets, take the Planets away, and put the Wire of the Comet ſo, that both its Focus may be in the Sun's Center, and its Plain elevated above, and depreſs'd below, that of the Ecliptick in the Angle of 5 Degrees here given. On the Wire is a Ball for the Comet's Body, with Hairs oppoſite to the Sun for its Tail; and move it up and down the Wire. This ſhews the Motion of the Comet, *A. D.* 1680, and ſerves for an Example: The reſt of thoſe Comets are deſcribed on the Solar Syſtem.

As for the Seaſons of the Year, *&c.* they are fully demonſtrated by the *Aſſimilo*, in Partition 2 and 3; but the ſeveral Seaſons are likewiſe repreſented by a ſmall Globe, with its ſeveral Circles, on an Axis that is longer than the Globe; and that Axis put into Holes bored parallel to one another, and in an Angle of 66 Degrees and a half, at the out-ſide of the Ecliptick in four Points, *Aries*, *Cancer*, *Libra*, and *Capricorn*, and a Candle repreſenting the Sun at the Center; the Limit of whoſe light Hemiſphere will cut the Parallels to the Equator equally in *Aries* and *Libra*, and moſt unequally in *Cancer* and *Capricorn*; which will ſhew the greater Length of the Days in Summer, and Shortneſs in Winter.

The Solar Syſtem explained by the *Aſſimilo*.

This may ſuffice to give the Reader a Taſte of true Aſtronomy, as to the Syſtem of the Planets and Comets, and prepare the Way for the better underſtanding of Mr. *Whiſton*'s Solar Syſtem, which ought always to go along with this *Aſſimilo*.

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FINIS

The following Errors were committed by reaſon of the great Diſtance of the Author.

ERRATA.

PAge 17, l. 18. for 8, *read* 8. *p.* 23. *l.* 14, for Opinions, *r.* Opinion. *p.* 23. *l.* 4. in Notation, for trigid, *r.* Frigid. *p.* 26. *l.* 4. in Margin, for Trietitious, *r.* Fictitious. *p.* 47. *l.* 26. for Sun, *r.* Sum. *p.* 59. *l.* 6. to the, *r.* to that. *p.* 97. *l.* 7. for 757, *r.* 754. *p.* 99, *l.* 4. for Sun, *r.* Sum. *p.* 100, *l.* 13, for 504, *r.* 540. *p.* 103, *l.* 9, for Dat, *r.* Day. *p.* 106, *l.* 15, for remonſtrate, *r.* and demonſtrate, *ditto*, *p.* 106, *l.* 22, for 2628. *r.* 2688. *p.* 107, Figure 1, for NW by W. *r.* SW by W. *p.* 107, *l.* 12, for NW by W. *r.* SW by W. *p.* 107, *l.* 7. in Notation, for to B, *r.* LB. *p. ditto*, *l.* 9, for 3818, *r.* 3878. *p.* 109, Figure 2, for O, *r.* D. fig. *ditto*, for SWW, *r.* SW half W. fig. *ditto*, for NWW, *r.* SW by W. *p. ditto*, *l.* 8. in Notation, for to C, *r.* LC. *p. ditto*, *l.* 9. for Lat. *r.* Cut. *p.* 109, *l.* 12, for Sine, *r.* Sine Comp. *p.* 110, *l.* 3, for SW half S. *r.* SW half W. *p.* 111. Fig. 3, for I. *r.* L. Fig. *ditto*, for SWW, *r.* SW half W. Fig. *ditto*, where the Arch H cuts Merid. G ſhould be placed, *p. ditto*, *l.* 6. in Notation, for SR, *r.* SK. *p. ditto*, *l.* 19. for Merid. *r.* Middle. *p.* 112, *l.* 5, for N *r.* W. *p.* 113. Figure 4, for Wn, *r.* Ww. *p. ditto*, *l.* 5, in Notation for DS, *r.* KS. *p. ditto*, *l.* 9, for CK, *r.* SK. *p.* 116, *l.* 11, for what, *r.* with. *p.* 121, *l.* 21, for place, *r.* placed, *p.* 122, *l.* 2, in Margin *dele* the. *p.* 123, *l.* 4, for to, *r.* ſo, *p.* 123, *l.* 8. for the, *r.* to. *p.* 123, *l.* 8, for c a c, *r.* b a c. *p.* 123, *l.* 9, for a c, *r.* a b. *p.* 127, *l.* 3, for 35.18. *r.* 85.18. *p.* 132, *l.* 4, in Notation for go, *r.* 90. *p.* 134, *l.* 1. in Notation, for 30.33. *r.* 38.30. *p.* 137, *l.* 26. for Aſcenſion, *r.* Deſcenſion. *p.* 138, *l.* 7. in Notation COCX, *r.* bo is bx. *p.* 138 & 139, in the Notation and Proportions, for c, *r.* b. *p.* 140, *l.* 6. in Notation for OA, *r.* Od. *p.* 143, *l.* 2, for cut it, *r.* but if. *p.* 144, *l.* 10 & 12, for to W and N. *r.* toward N. *p.* 148, *l.* 7. for 28. *r.* 82.